MACHINERY.

April, 1903.

AMONG THE SHOPS.

NOTES ON ELECTRIC WELDING—NEW SHOPS OF THE STANDARD ROLLER BEARING CO., PHILADELPHIA—MISCELLANEOUS DATA.

AMONG the applications of electricity to useful purpcses, that of electric welding is probably less appreciated or understood than any other important use to which it is adapted in the arts. We believe that even the recent developments in electro-chemistry that have come about since the establishment of the first Niagara Falls power plant are more widely known than are the possibilities of electric welding. The process is used, however, by many large manufacturers, especially in the lines of carriage hardware, wire and wire goods, and bicycle and automobile parts; and for miscellaneous work of almost endless variety, such as welding street railway rails, lengths of piping, chains, printers' chases, carpenters' squares, the teeth of large saws, axe heads, etc.

It is also probable that of the various plants using electric welding processes, that of the Standard Welding Co., Cleveland, O., is of the greatest interest, because of the variety of welding that is accomplished there. The first time that the writer called at these works it was a matter of surprise to him to find a power plant of such proportions as it required for supplying the current for the welding operations. A view of the engine room is shown on this page. It is equipped with a modern vertical engine of 500 horse power, direct-connected to a General Electric 350 K. W. generator with revolving fields, especially designed for electric welding purposes. The engine has Corliss valves, with shaft governor, and the generator supplies a two-phase current, operating at 350 volts with 500 amperes per phase. The whole power of this generating unit is required for supplying the current to the different welding machines in the works, which indicates the extent to which this new branch of the metal-working industry has been developed in this one plant alone.

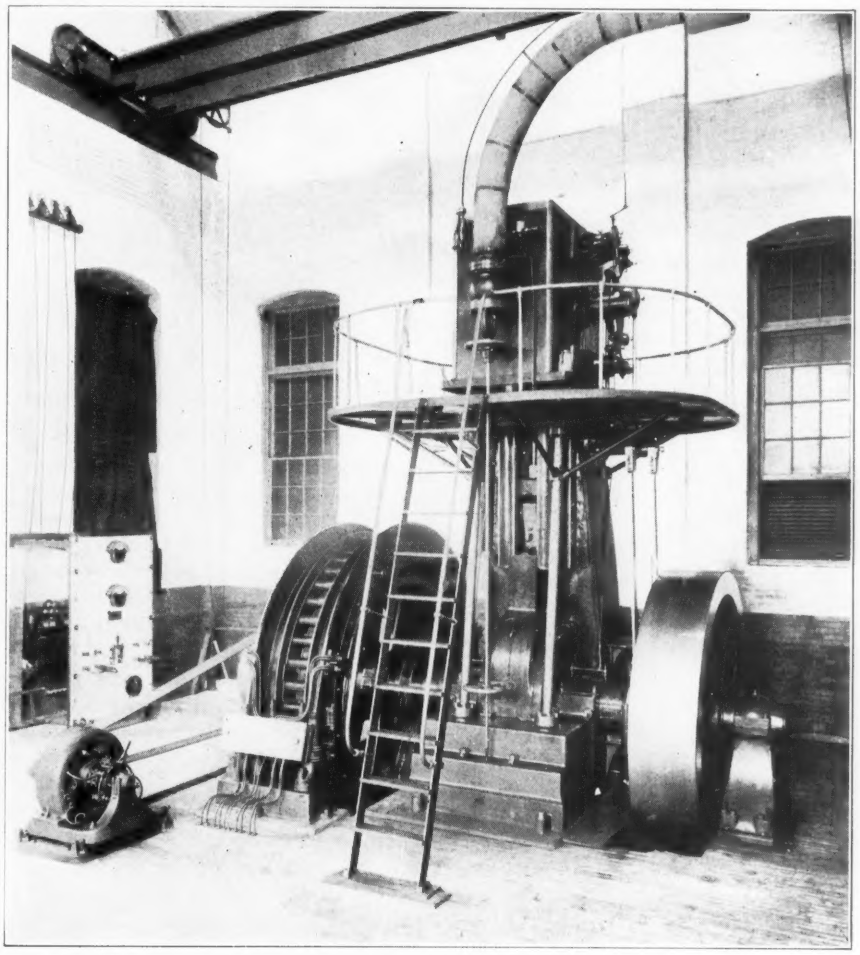


Fig. 1. Engine Room of Standard Welding Co., Cleveland, O. Five hundred H. P. Engine and Generator used for Supplying Current to Electric Welding Machines.

The Standard Welding Co. is unique in that its entire business consists in electric welding and nothing else; or at least in manufacturing articles in which electric welding is an integral part of the process, without which the products would have to be manufactured in an entirely different way and in most cases at a greatly increased cost. In connection with products that are regularly manufactured and sold is a well-equipped jobbing department where work of all descriptions within the capacity of their machines is welded for the trade. Here various kinds of articles which it is practically impossible to weld by the forge method, are electrically welded. But no work is solicited for this department which can be economically welded by ordinary methods, since electric welding has its own distinctive field of usefulness in making it possible to produce certain articles by an entirely different course of procedure from what would ordinarily be followed. This is practically a new field, which as yet has not been adequately explored, and many manufacturers of all kinds of machinery could undoubtedly adopt the method of making different parts or sections of pieces separately and then finishing by welding, producing a superior article at greatly reduced cost. This method also permits using complicated machine parts, if desired, without entailing a high cost of production. One feature is the possibility of reducing the cost of screw machine work or of eliminating some of it altogether.

This can be accomplished where a large amount of metal would ordinarily be removed from the bar, producing a shank of much smaller diameter than the other parts of the piece. By using stock of small diameter for the shank and welding it to the larger piece, after both have been finished, the completed product may be obtained equal in every way to that produced entirely on the screw machine. By means of a swaging machine taper stock can be produced and welded to a straight body; tool steel can be welded to machine steel or iron; and where lightness or strength is desirable a piece built up partly of tubing and partly of solid stock—as where a link or stay is required—having solid eye ends.

The chief product manufactured by the Standard Welding Co. is tubing, made from cold-rolled open-hearth steel, which is rolled into cylindrical form and electrically welded and finished by drawing, swaging, and polishing in the usual manner in which all tubes manufactured by the hot piercing and rolling process are finished. Reducing the diameter of

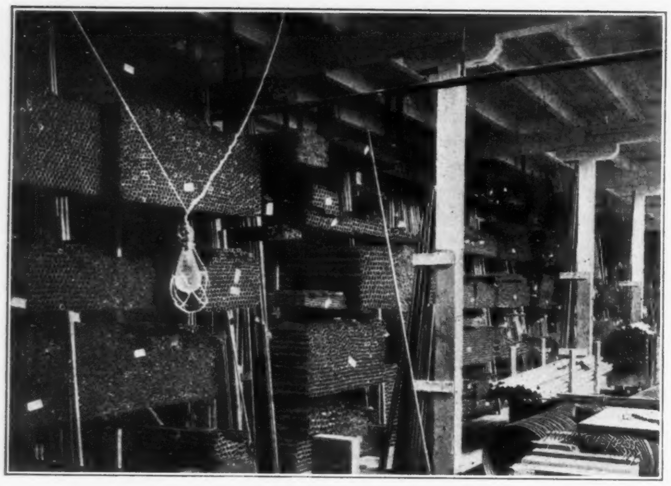


Fig. 2. View of Stock Room showing Stock of Tubing.

the tubing on the draw bench makes a severe test of the joint at the seam, which, however, is known by many laboratory tests to be as strong as the rest of the metal. In fact, one of the products turned out with success is tubular steel bottles in sizes up to and including five inches diameter, which are intended for the storage of compressed gases and are regularly tested at 4,000 pounds per square inch. These are made by welding the caps and bottoms to sections of open-hearth tubes made by the electric welding process. The extent of the tubing branch of the business can be judged by the stock of tubes shown in the illustration, which is from a photograph of the stock room.

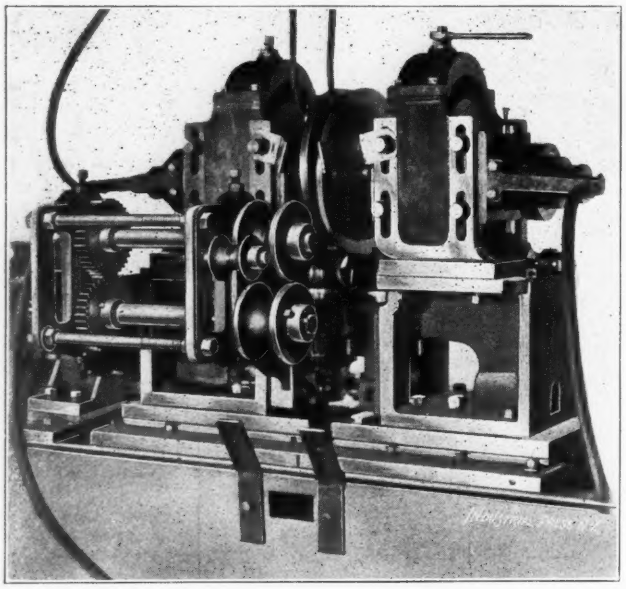


Fig. 4. Machine for Welding the Longitudinal Seam in Tubing.

The next most important item of manufacture is that of rims for automobiles and carriages—principally the former—these being made in standard sizes and shapes, gaged accurately to dimensions, so that the wheels to which they are to be applied may also be made up in standard sizes and both wheels and rims be interchangeable.

Still another important feature is the manufacture of bent parts from the tubing which they make, for use by bicycle manufacturers, such as rear forks and stays, fork sides, fork stems and seat posts, together with bent tubes for frames for ladies' bicycles.

Electric welding is carried on under the patents of Elihu Thomson, which are controlled in this country by the Thomson Electric Welding Co., Lynn, Mass. The principle involved in electric welding is that of passing currents of electricity through the abutting ends of pieces of metal to be joined, thereby generating heat at the point of contact, while at the same time pressure is applied to force the parts together. As the current brings the metal to the welding temperature and the surfaces to be united become soft the end pressure causes the opposing points of these surfaces to come into intimate contact and form a perfect weld.

Nearly all machinery for electric welding is of special design, to adapt it to the various classes of work. A welding machine consists primarily of a transformer, by which alternating currents of comparatively high pressure and small flow may be changed to currents of very low pressure and great volume, mounted in a suitable frame bolted to two gun-metal or copper tables on which the clamps for holding the pieces to be welded are placed. The current from the transformer enters the piece to be welded by the holding clamp, and passes through the joint between the pieces, heating the metal at the joint and a small distance on each side of it. The operation of welding is performed very quickly, the time required depending upon the power applied and the cross-sectional area of the metal to be joined. For very small work, up to ¼-inch in diameter, semi-automatic welding machines are used, on which as many as 8,000 welds have

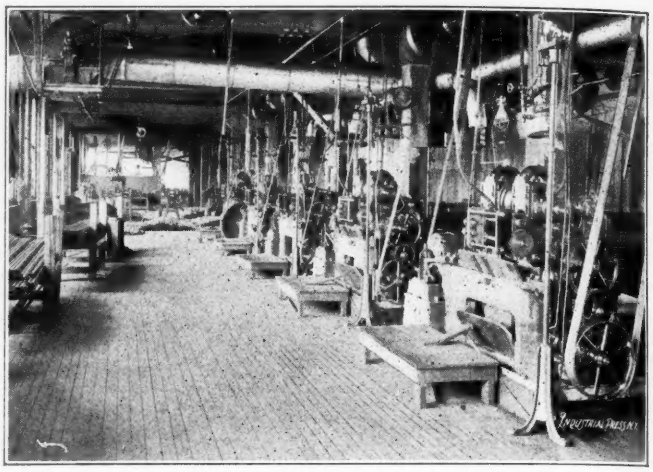


Fig. 3. Row of Electric Welding Machines in Tubing Department.

been made in a day of ten hours. In some work of larger size, requiring care in adjusting the pieces, the speed may be as low as 200 or 300 welds in the same time. Two horse power applied to the dynamo is sufficient to weld a piece ¼-inch in diameter in 2 seconds; a piece ¾ inch in diameter can be welded in 18 seconds, with about 13 horse power. It is found that about 28 horse power is required to weld one square inch area of iron or steel in 45 seconds. To weld a piece of twice this area, twice the horse power would theoretically be required, although practically a little more than double the power would be necessary. A piece 4 square inches in area requires 84 H. P., to be welded in 90 seconds.

In heating pieces to be welded in a forge the outer surfaces become hotter than the interior, inasmuch as the heat has to travel from the outside toward the inner sections, and there is more or less scaling and sometimes blistering. To

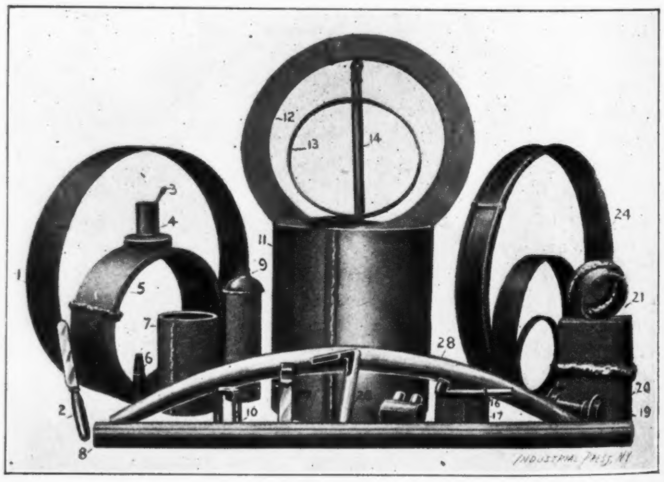


Fig. 5. Group of Electrically-welded Pieces. See List on Next Page.

offset this some flux is employed, particularly in the case of steel, which is difficult to weld by the ordinary method. The heat also travels along the piece, often injuring parts of metal not required for the welding. In electric welding there is absolute control over the heat, the process can be continually watched and there is no formation of scale, tending to produce an imperfect weld. The heat effect is from the center toward the outside of the piece, and when the weld is made the structure of the metal at the joint is the same as elsewhere. A great advantage also is the fact that various kinds of metals, such as copper, can be welded; or two different kinds of metals may be joined where heretofore the welding could be produced only by the greatly inferior process of brazing.

The tubing manufactured by the Standard Welding Co. is made from flat sheets of steel, formed into the shape of a cylinder by passing between pairs of grooved rolls, the axes of these being alternately in vertical and horizontal planes, so located as to draw the edges of the steel together to form the tube. In Fig. 3 is a view of the section of the tubing department, showing a row of electric welding machines designed especially for this class of work. Fig. 4 gives a front view of one of these machines. In this the tubing, previously rolled into cylindrical form, is fed to the machine and the edges pressed together by the grooved rollers. Then the edges of the tube come in contact with the peripheries of two rotating discs which serve as contact points by which the current is made to pass through the section to be welded.

Fig. 5 is a reproduction of a photograph from a collection of pieces of various descriptions turned out in the different departments, and illustrating the variety of uses to which electric welding can be applied. A list explaining Fig. 5 is given herewith:

1. Cylindrical band 6 inches wide by ¼ inch thick.
2. Knife handle (steel).
3. Crucible steel end welded to machinery steel.
4. Gear case housing—steel tube welded to stamping.
5. Iron ring for magnetic field circuit for motor vehicles.
6. Taper plug for handle bar—stem welded to straight tube.
7. Cream separator bowl.
8. Electrically welded tubing 2 inches O. D. by 13 gauge.
9. Nitrous oxide gas bottle, tested to 4,000 pounds.
10. Continuous band, bicycle pedal.
11. Cylinder for soda water tanks, tested to 600 pounds.
12. Disk 3 inches by ¼ inch for automobile flanges.
13. Baby carriage tire.
14. Kelly handle bar forging, welded to steel tube.
15. Oval tube, 13 gauge.
16. Bicycle seat post forging with welded extension.
17. Retaining band, 7 inches by .090 inch for soda water cylinders.
18. Bicycle bottom bracket.
19. Pressed steel automobile hub.
20. Section of Bessemer steel, welded, 6 inches by 2 inches.
21. 4-inch steel tube by ¼ inch walls.
24. Standard clincher rim, Goodrich type.
26. Bicycle seat post.
27. Part of butcher's saw frame.
28. Tubular arch for Baker motor vehicle, made from tubing.

NOTES FROM THE GARVIN MACHINE CO., NEW YORK.

A form of inserted-tooth milling cutter is quite generally used in the extensive machine shops of the Garvin Machine Co., New York, which, we believe, is rarely met with in other shops. The feature that distinguishes this cutter from others is the manner of recessing for the cutters and the location and form of the binding screws. The principle of construction is shown in Fig. 1, which is not drawn to scale but only given to illustrate the idea.

The cutter body is turned on the edge to the approximate shape shown, the longer or upper side being at an angle of, say, 30 degrees with the axis of the work spindle. The slots for the cutters are milled at the same angle, but before this is done the holes for the binding screws are drilled and tapped and then the slots are milled directly through the center of the holes, leaving an equal amount of thread on each side. The screws are necessarily short and of comparatively large diameter for the size of steel in the cutters. These features, together with that of the interrupted thread, might be thought to render the fastening somewhat insecure, but it apparently works well in practice.

A sort of universal jig attachment is provided for almost all the upright drills in this shop, which is of a simple character but one, nevertheless, that has been found most useful on many classes of work that must be drilled to a certain degree of interchangeability, and for which regular jigs would be too expensive. It consists of an angle piece, *A*, Fig. 2, clamped to the vertical column of the drill so as to be adjustable vertically. The outer end is bored concentric with the drill spindle on the drill itself, for a guide bushing *C*. A series of guide bushings are, of course, supplied for all sizes of drills used, the same as with the regular jigs. On the under side of the angle piece is planed a shallow groove lengthways of the horizontal arm, and in this is fitted the tongue of a Y-shaped piece *D*. This piece is slotted for a clamping screw, as shown in the plan view in the upper part of the cut, Fig. 2.

The idea of this jig is to provide means by which round bosses such as the ends of levers, connecting-rods, bell-cranks

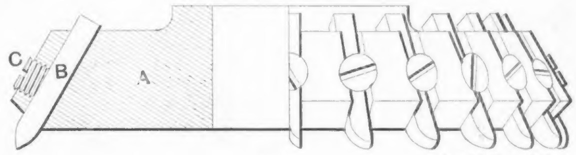


Fig. 1.

and similar parts that are a large part of the work on certain classes of machinery, like paper bag machines, etc., can be automatically centered without the use of a special jig for each piece. The device is also used to get the holes at exact distances apart, as also shown in the plan in Fig. 2. After the hole in one end of a lot of levers has been drilled, a stud, *F*, is located on the drill-press table, which closely fits the holes. This stud is so located as to permit the other end of the lever that is to be drilled to swing into the angle of the Y-shaped piece and center under the drill. It will be understood that the operation of setting a piece to be drilled in this manner is much quicker than the telling of it.

An interesting machine in this shop is a special tool designed by Mr. Norton for boring the holes for the spindle, overhanging arm and back gears in the frames of milling machines, also drilling the holes for the binder screws for the overhanging arm and sawing the slots—all at one setting.

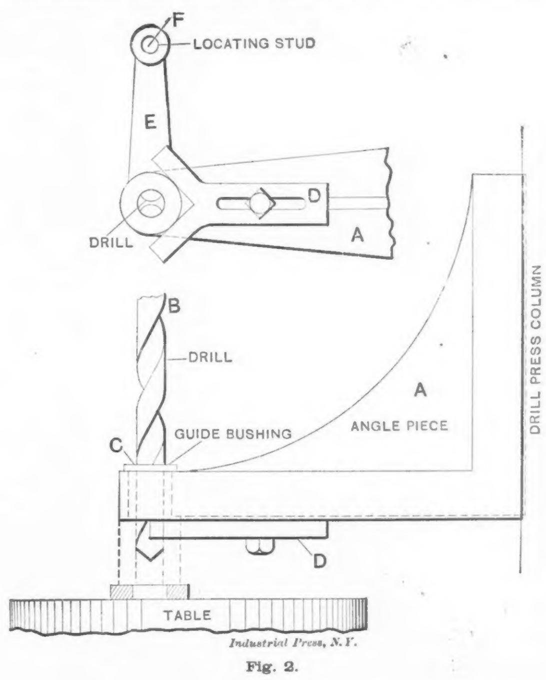


Fig. 2.

The machine has a complete and expensive equipment of boring bars, cutters, etc., for all the sizes and styles of column milling machines built by the company. The three holes for the spindle, overhanging arm and back gears are all bored at the same time. The drilling of the binder holes and sawing of the slots so that the metal may be gripped onto the overhanging arm, are done afterward.

In making cone belt pulleys, it is the practice to first bore them in a Beaman & Smith double-head machine, boring from each end at the same time with boring bars carrying one cutter each. A recess is, of course, cored in the middle, so that clearance is given between the two bars, that a hole

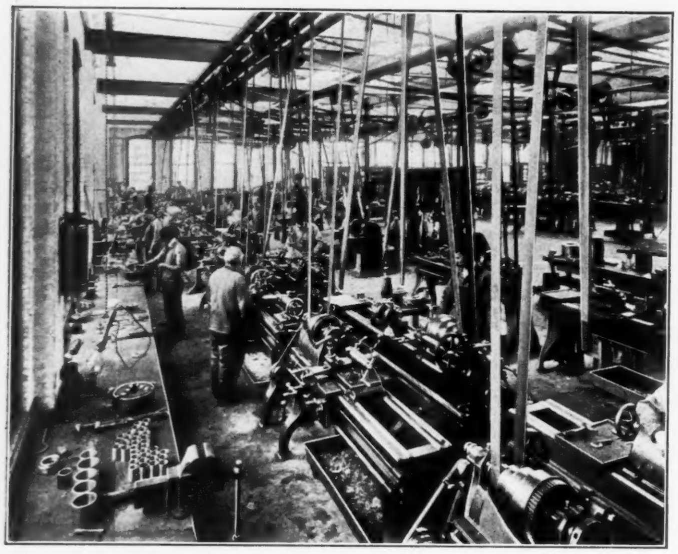


Fig. 1. General View in New Machine Shop of Standard Roller Bearing Co.

may be finished without interference. The cone pulley casting is held between the two heads of the machine in a simple frame or jig which is adjustable so as to be universal for the different sizes of cones. The same machine, with other jigs, is used for many other operations of equally novel character.

The Garvin shop being in a large city is naturally built in a vertical direction rather than being extended over a large area. The building is eight stories high, besides the basement, making nine floors in all. Of course elevators are provided, which make the trip from one floor to the other quick and easy; still it is scarcely expedient to use them for transporting tools from the tool room to the different floors, so auxiliary tool rooms are provided which carry a small stock of the tools most called for in each department, and the others are requisitioned from the main tool room by means of a chain conveyor. The order is carried down to the main tool room and the required tool brought back in the same manner. The conveyor runs constantly in one direction, the flights or buckets being so constructed as to always remain right side up while making the circuit.

The drawing room is a well-lighted room with 11 drawing tables. These tables are so constructed that a draftsman can work on any side without interference with the table support. The support is a cast-iron column screwed to the floor, and the table is secured to the top of the column in a horizontal position, the arrangement being non-adjustable. Over 4,000 drawings are filed in cases in the drawing room, and all originals are also preserved. The card index is used for reference.

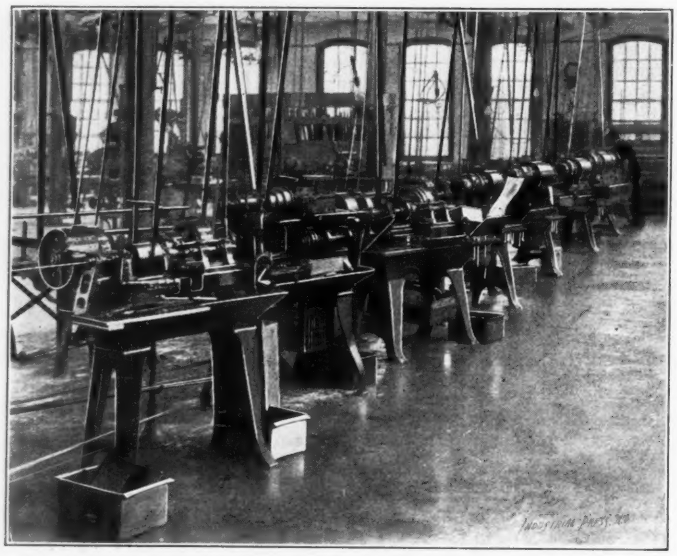


Fig. 3. Row of Screw Machines making Rollers and other Small Parts of Bearings.

NEW SHOPS OF THE STANDARD ROLLER BEARING CO., PHILADELPHIA.

The Standard Roller Bearing Company, Philadelphia, are now located in their new factory, which is situated upon a tract of three acres facing upon the main line of the Pennsylvania Railroad, about 10 minutes' ride from City Hall. The buildings consist of a three-story brick building 60 by 200 feet, an office building 25 by 75 feet, main shop 150 by 200 feet, with boiler house engine room and blacksmith and forging shops built adjoining the main shop, but separated by fire walls. All buildings are of brick and steel construction and the roof of the main machine shop is of the saw-tooth variety, facing north, which gives a strong light throughout the shop. A record was established in building the main shop. In 47 days from the breaking of ground the entire building was finished, complete in all respects, and in four months from the breaking of ground the machinery had been moved from the old factory in the center of the city and was set up and running to full capacity in the new factory without interfering with shipments to any extent. A brass foundry is now nearly finished and an addition to the main shop 125 by 320 feet will be erected during the coming summer.

The Departments.

At one end of the machine shop are the drafting room, pattern room and stock room, and adjoining the latter, the shipping department. At the other end of the building, a side-

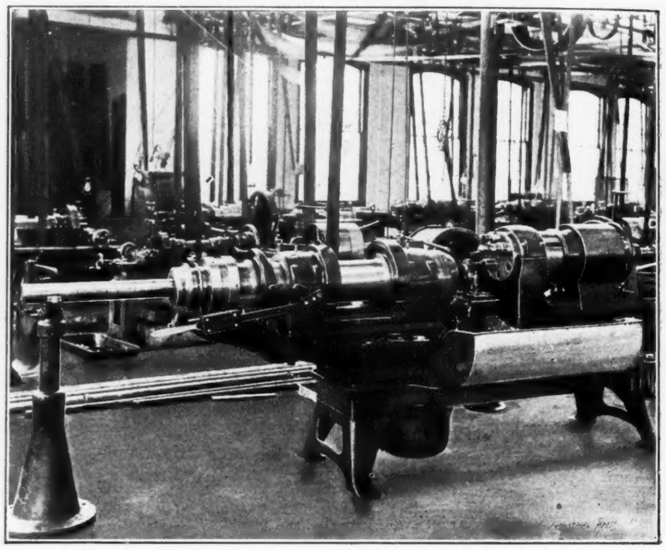


Fig. 2. The Largest Automatic Screw Machine ever built; Operates on a 6-inch Bar.

track runs into the property adjoining the main machine shop and is formed into a steel storage room. All of the steel used is brought in at this point, the machines being set in such a manner that the steel is gradually worked from one department to the other, until at the other end of the building it comes out as finished stock.

In the center of the building is located the tool room, being a small room separated by wire netting from the balance of the shop. After the tools are made, they are placed in another separate room, from which tools are taken as they are required by the machinists, who leave the usual check for each tool as they receive it. On Saturday of each week, all tools are returned and checked off and delivered again to each workman on the following Monday.

On one side of the shop, and in a department by itself, are lathes in two lines. This department turns out the special sizes of bearings which cannot be made to advantage on automatic machines. Adjoining this, is the milling machine department, and in another separate department are two rows of Cleveland automatic machines, and two rows of hand screw machines. At the other end of the building, also in a separate department, are the drilling and special machines used for making roller bearing and ball bearing cages, thrust cages, etc. Adjoining this is the grinding department, consisting of a number of external grinders, with water attachment; and about sixty universal grinders, each of the latter

being connected with an exhaust fan, which draws all emery dust through pipes, carrying it to a tank upon the roof, the result being that this department is as clean and free from dust as the lathe or any other department.

In the power plant is a Berry Boiler and a C. H. Brown engine, which, by the way, is an exceptionally quiet-running engine. A Crocker-Wheeler generator produces electricity for lighting and other purposes, and also for power in the three-story building above referred to, which is used for assembling, storage, etc. The engine is connected by ordinary belt drive, with three main lines of shaft, all the latter being equipped with Standard roller bearings. The main drive connections are made in the center of the building, each being connected with a friction clutch made by the Medart Patent Pulley Co., the result being that any one of the six departments may be run separately if desired.

The principal product consists of grooved ball thrust bearings, roller thrust bearings, ball thrust collar bearings and roller journal bearings. The rollers for the bearings are ground to gage after being hardened. With the journal roller bearings are furnished hardened steel sleeves or bushings, one to be forced on the shaft and the other to be forced into the box or housing over the rollers, so that the rollers have hardened steel to run upon. The bushings are ground accurately inside and out, so that they are perfectly parallel. This work is done on universal grinding machines.

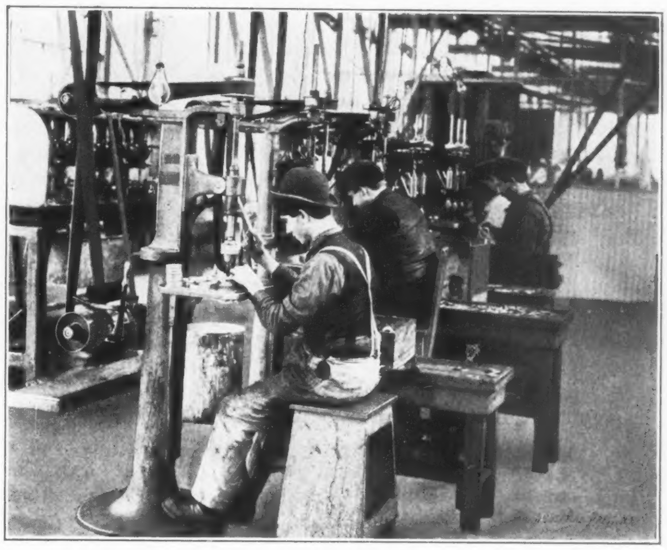


Fig. 4. Row of Drills.

Fig. 5. Grinding Rings for Grooved Ball Thrust Bearing.

With both ball and roller thrust bearings, hardened steel washers are furnished, ground accurately upon both sides, after being carefully hardened. Tool steel is rarely used in bearings, owing to the fact that it breaks or chips very easily and does not give as good results as case-hardened steel. The steel washers, sleeves, etc., are case-hardened to a depth of from 1-64 inch to ½ inch, according to the weight, etc., to be placed upon the bearing, the depth usually being about one-third the thickness of the piece, leaving the center third soft. The hardening is done by placing the steel in cast iron boxes, in a preparation of bone, and baking it from eight hours to forty-eight hours, according to the depth desired. Steel treated in this manner has great toughness, owing to the fact that the center is soft while the outside gives a glass hard wearing surface, and is in effect, tool steel on the outside and machinery steel inside. Case-hardened pieces can be bent to a considerable degree without cracking, while the outside surface is so hard that a file cannot cut it. Any depth of hardening that may be required can be readily furnished after sufficient experience, and it is probable that case-hardened steel will be more generally used as its merits become better understood. A fracture of case-hardened steel shows a very fine grain, similar to tool steel on the edge, the center being of a larger grain and similar to ordinary machine steel. The case-hardening department consists of six furnaces, having a capacity of about 4,000 pounds per day. Fuel oil is used exclusively in these furnaces, as it gives a very uniform heat, and one easily controlled. The furnaces were designed by the Standard Roller Bearing Company, but are very similar to the Brown & Sharpe type. In addition to the case-hardening furnaces are three coal forges, drop hammer, and the necessary water and oil tanks for tempering.

A number of special machines are in use, designed for the manufacture of roller bearings. One of these is a six-inch automatic screw machine which will work up a six-inch bar, weighing 3,500 pounds, entirely automatically. It is used in making ball thrust collars and rings. It is powerfully geared, with two forward speeds and several cone changes on the countershaft. There are six holes in the turret and a section of the bar 6¾ inches long can be operated on at one setting. This machine was built especially for this work by the Cleveland Automatic Machine Co., Cleveland, O., and so far as we are informed is the largest automatic screw machine ever constructed.

A special machine was designed for drilling roller thrust cages, as is shown in the illustration. This machine works automatically, drilling to a certain depth, when the turret moves backward, turning at the same time to the next point to drill, continuing the operation until ten, twelve, sixteen or more holes are drilled in the thrust cage. This machine is fitted for drilling either steel or brass, having a pump attachment to force oil when drilling steel.

A Rogers & Hurlbut cutting-off machine has been fitted up with a special pump for forcing oil upon the cutting-off tool. This has been done at a very slight expense, and has resulted in an increase in the output of the machine of from 30 to 40 per cent. at an increase of not over $25.00, in addition to which it keeps the tools in excellent condition.

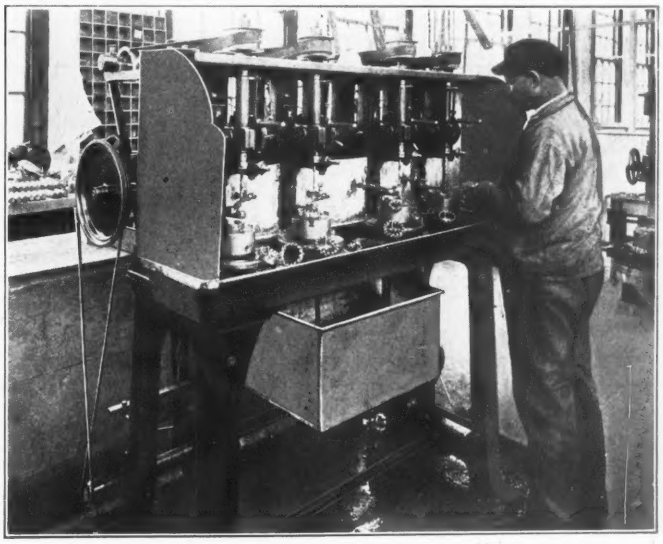


Fig. 6. Special Machine for Drilling Cage Ends.

An interesting testing machine has been made to give a graphic illustration of the utility of bearings, especially under heavy pressures. This machine contains a thrust bearing, the rings of which have an outside diameter of 8 inches and an inside diameter of 4 inches. It is arranged so that by compressing a spring a pressure of any amount up to the capacity of the machine can be brought against the bearing. Under 5,000 pounds' total pressure the bearing can be turned easily by hand by means of a small handle attached to one of the rings. With rollers removed it would not be possible, of course, to move the disks at all.

The use of roller bearings has grown materially during the past few years. At our request a list has been prepared of the different uses to which bearings sold by this firm have been put, and opposite each name is given the number of firms using these bearings for the different purposes enumerated. Some bearings have been made of unusual dimensions, for very heavy duty. The Russian government has had several, to be used in a testing machine on a 10-inch shaft. These bearings are 14 inches long with 1¼-inch rollers and carry 400,000 pounds each, at 200 R. P. M. The United States government has recently tested a roller thrust bearing successfully under 80,000 pounds pressure and at 300 R. P. M. The outside diameter of this bearing was 22 inches. For very heavy work roller bearings are preferred to ball bearings. It has generally been assumed that roller thrust bearings should be designed with taper rollers or cones, so that a roller will be in perfect rolling contact at every point and operate without slipping. This company, however, have had good success with a thrust bearing having a disk or cage containing a large number of very short rollers arranged with their axes radial. While theoretically there would be a small amount of slip, practically with so short rollers this is negligible, and this type is recommended for nearly all purposes where a heavy thrust is to be taken. The most interesting application of these is for marine work in place of the usual horse-shoe thrust bearing almost universally used on steamships and yachts. Roller bearings of this construction need no water jackets and but little oil. In one instance the saving of oil—which is a considerable factor—was reported as 85 per cent. Propeller shafts for vessels up to 5,000 tons displacement have been fitted with these bearings, with the result of an average increase in the speed of ¾ knot per hour. In one case the saving of 1¼ knot per hour was reported by the captain of the vessel. It is estimated that if an ocean liner should have as great an increase in speed through the application of roller thrust bearings as the smaller vessels have shown, the trip from New York to Southampton could be made in one-half day's less time than at present.

The standard type of cylindrical bearing adopted carries rollers in a cage in the usual manner, but each end of each roller is rounded and bears against a steel ball which is perfectly free to turn, but is retained in place by the construction of the cage. It has been found that without these steel balls there is so much friction at the ends of the rollers, whenever there is any tendency toward an end thrust of the shaft, that the rollers and cage become twisted and do not remain in axial alignment with the shaft. It is evident that in some cases the rollers in rotating would bear against one end of the cage and tend to retard the rotation of that end; while the cage containing the free ends of the rollers would tend to forge ahead, producing the twisting action referred to. It has been found that the insertion of a ball at each end of each roller prevents this. The balls constantly present new surfaces for the rollers to bear against, and as they are very smooth and hard they make excellent thrust bearings for the rollers. An additional advantage of this construction is that the balls prevent the cage from wearing out.

* * *

List showing the Varied Uses to which Bearings made by the Standard Roller Bearing Company have been put and the Number of Firms using them.

Engines	5	Windmills	2	Horizontal Shafts	1
Drills	16	Fans	5	Boring	[illegible]
Launches	7	Armoring Machines	1	Milling Machines	1
Elevators	12	Cotton Baling Machinery	1	Dampers	1
Bolt and Nut Machinery	2	Broaching Machines	1	Planers	4
Valves	3	Tapping Machines	1	Riveters	1
Motors	4	Coating Machines	1	Hoe Carts	1
Pumps	5	Heel Finishing Machines	1	Die Cutters	1
Schooner Yachts	1	Axle Machines	1	Slotters	2
Rubber Machinery	1	Griffin Mills	1	Special Machines	6
Turn Tables	2	Tubing Machines	4	Wood Working Machinery	5
Automobiles	21	Grinding Machines	6	Electric Striking Machines	1
Steering Apparatus	4	High Speed Machinery	1	Water Wheels	4
Cranes	25	Power Saws	1	Transmission Gears	1
Hacking Screws	2	Steel Roll Mangle Machines	1	Combing Machines	1
Saw Mill Log Carriages	1	Disk Harrows	1	Street Wagons	1
Vertical Shafts	7	Revolving Lights	1	Electric Motor Signals	1
Punching & Shearing	1	Agricultural Implements	1	Hoists	2
Experimental	7	Feed Mills	1	Distillery Presses	1
Pumps	1	Flying Horses	2	Shafting Machinery	1
Misc. End Thrusts	14	Corn Huskers and Shredders	1	Mash Machines	1
Engine Governors	5	Boring and Turning	1	Barrows	1
Lathes	7	Well Drill Machines	1	Road Scrapers	1
Electric Tools	1	Light Running Special Machinery	2	Lamp Wick Machinery	1
Shingle Machinery	1	Tumbling Barrels	1	Cutters	1
Doors (Safe)	1	Drill Presses	3	Tool Slides	1
Trucks	8	Pulley Turning and Boring	1	Tubular Wheels	1
Shapers	5	Knitting Machines	1	Steel Bending Machines	1
Bottle Washing Machinery	1	Friction Hoists	1		

POWER REQUIRED FOR LATHES USING HIGH-SPEED TOOLS.

It has been quite fully demonstrated, we think, that machine tools of the older types now in general use, especially lathes, are not capable of giving the maximum output possible with the high-speed steels that are now so rapidly coming into general use. Being designed for surface speeds of something like 25 or 30 feet per minute, they have not the strength and rigidity that must accompany a tool cutting at a surface speed of, say, 60, 80 or perhaps more than 100 feet per minute. If the power required increased in direct proportion to the speed, the conditions would not be quite so severe on the older machines, but it does not. In a lecture delivered before the Keighley Technical Institute, Mr. John Miley said that the power required for a surface speed of 80 feet per minute—cut being 3-16 inch deep and feed 1-16 inch—was about 8 times that required with the same feed and cut at 20 feet per minute. He mentioned a test made with a 24-inch lathe driven by a 10 horse power motor. This motor was found of insufficient power and a 26 horse power motor was substituted instead. The belt cone was driven at 1,000 turns per minute and at this speed it took no less than 6½ horse power to drive the lathe, with the work between the centers, and the feed gear operating the saddle, but without the tool touching the work. It absorbed 13 horse power to do this work—that is to say, it took 6½ horse power to drive the lathe empty at that speed, and 6½ horse power to remove this weight of cuttings, 5 pounds per minute. When the cut was increased to ⅜ inch deep instead of ¼ inch, it removed 7 pounds per minute, but required 20 horse power to drive it; thus 7 horse power extra was absorbed in removing an extra 2 pounds of cuttings per minute. From this it is evident that the power goes up more than in direct proportion to the weight of the cuttings removed.

* * *

A bridge has been erected on the line of the Pacific Railway in Costa Rica to span the Rio Grande River. It is higher than any bridge in the United States, being 340 feet from the tops of the rails to the bed of the stream. The length of the structure is 685 feet and its total weight is 932.5 tons.

SHOP CONSTRUCTION.—7.

LIGHTING - ARRANGEMENT OF WINDOWS AND LAMPS.

OSCAR E. PERRIGO.

The heating and ventilation of our manufacturing buildings having been duly provided for in the last article, the next question of importance to be considered is that of lighting, which forms the subject of the present article.

In considering the matter of lighting manufacturing buildings we may properly divide the subject into two parts. The first of these relates to the utilization and management of the sunlight for our use during the daytime; and the second, to the artificial light which we must provide in the absence of sunlight and in the dark and obscure corners, of which there should be as few as possible in the modern shop.

For properly lighting a shop during the daytime, many forms and proportions of windows have been devised, from those of small area and diminutive lights of glass, to those very high and narrow; those broad and low; those of large area placed far apart; those of much less area placed near together; those covering almost the entire wall with glass area; those placed vertical and those in an inclined position; those placed as skylights in the roof; and those placed in the ventilating space at the top, or ridge of the roof. Again, as to the kind and quality of glass used. Some prefer the ordinary plain glass, admitting a flood of light, regulating it by means of shades or curtains. Others use the same glass, "stippling" the surface with white lead paint to relieve the eyes of the glaring light. Again, ground glass is used. Still others prefer the rough cast or "cathedral" glass, as it is sometimes called. One inventor proposes to construct windows composed of a series of round rods of glass placed closely together, and states that one of its advantages is that if broken by a flying chip, or in any similar manner, only one or at most a few of the rods will be injured, and these may be easily and cheaply replaced.

In reviewing these various methods of construction it may be said that broad and low windows in the side walls will light the bench at the wall and perhaps one or two rows of machines, while the center of the room receives little or no illumination. This condition is sometimes sought to be remedied by the use of skylights in the roof. Windows placed too high in the side walls will light the center of the room but leave the benches around the walls in the shadows of the high window sills. Therefore it is proper to so locate the window sill as to afford proper light at the bench vises; then to continue the window well up to the ceiling in order that the whole room may receive, as nearly as may be, an equal quantity of light. The width of the windows and their distance apart is a matter of great difference of opinion. Where the construction is of steel or wood they may be placed less than two feet apart, if it seems necessary to do this. Where brick walls are used the distance should generally be more, depending, of course, on the entire height of the wall. In our arrangement of the windows in the machine shop (as given in our article in the November, 1902, number), the size is, four feet wide and ten feet high. These figures are the dimensions of the inside of the sashes, therefore providing forty square feet of glass. This will make the opening in the wall nearly five feet wide, which, with bays of eighteen feet three inches centers—two windows to each bay—will give about four feet two inches of brickwork between the windows. This will give sufficient strength to the side walls, and will also provide quite enough light for all ordinary classes of machine shop work to be done in such a building.

Skylights should not be used where they can be avoided, as they are a prolific source of leaky roofs, damage by accidental breakage, as well as numerous other difficulties, and even a light fall of snow quite destroys their lighting properties. Windows in the ventilating portion of the roof are not only useful for lighting the central portion of the shop, but they conveniently act as ventilators when the sashes are hung on pivots and handled by cords. They may easily be so constructed as to avoid any trouble from leaking.

As to the kind of glass to be used the plain glass is, of course, the cheapest. It must, however, be shaded by curtains, which can be readily run up and down; and these are liable to get out of order and to require a continual expense to keep them in presentable and useful condition. The amount thus spent added to the cost of plain glass will soon pay for good ground glass which will need no curtains, and which, while rendering the light soft and agreeable to the eyes of the workmen, will also diffuse it over the area of the shop much better and more equally than the plain glass. At the same time none of the light is lost by interposed shades or curtains. As to "stippled" glass, the stipple is apt to crack and peal off, and will also absorb considerable dirt and grease, making it much more difficult to keep clean than clear or ground glass; and the repeated washings are apt to remove portions of the "stippling," leaving a patched and unsightly effect. The rough or "cathedral" glass is more expensive, not as agreeable to the eyes, and considerably lessens the volume of light. Windows of glass rods do not seem to have been sufficiently employed to demonstrate their usefulness.

We have seen shops in which practically the whole side wall was a mass of glass, only the space for the posts supporting the roof and the frames containing the sashes being opaque. Such a prodigality of light does not seem necessary in practice, and in fact it may be hurtful to the eyesight of the workmen, while the cost of construction and the continual cost of renewals and repairs of such a great quantity of glass will be a large initial expense as well as an important annual outlay.

Let us now consider the question of artificial light. First, the usual time during which we must provide for artificially lighting up the buildings. Omitting the six usual holidays of the year and calculating on the basis of a ten-hour day, we have 3,060 working hours in a year's work. If the working day begins at 7 A. M. and ends at 6 P. M., with one hour for dinner, we shall need artificial light, for the ordinarily well lighted shops, for about 460 hours out of the entire 3,060 working hours of the year. This will include "lighting-up time" divided among the different months as follows: January, 102 hours; February, 60 hours; March, 32 hours; May, 8 hours; June and July, none; August, 8 hours; September, 20 hours; October, 50 hours; November, 78 hours; and December, 102 hours. To properly provide for sufficient lighting during these periods we must select some one of the many systems in use, and the one which seems best adapted to the conditions of the case. Whatever may be the future development, either as to perfecting and simplifying its application, extending its sphere of usefulness, or reducing its cost, electricity at present stands at the head, when the question of a perfect light, or at least the most available one, is considered, for the illumination of nearly all classes of large buildings, particularly such as are used for manufacturing purposes. Still there seem to be indications that there may be yet other systems of artificial lighting which by development may become dangerous rivals of the popular systems of electric lighting—acetylene gas, for instance. This method is still in the infancy of its development and use, and there seem very few of the usual difficulties to be overcome excepting the danger of its explosion in the hands of inexperienced persons. This difficulty will probably be overcome in time and the use of it be as safe, both to generate and to manage, as electricity. It is also true that the system of electric lighting has many fatal accidents charged against it. These may all have been due to improperly-constructed apparatus, the careless management of it, or the imperfect knowledge of its properties and action. The same may be said of acetylene gas.

To provide an ample, proper, safe, and thorough system of illumination for buildings in which a large number of persons are obliged to labor for so many hours each year by its aid, would seem to be a matter that need not be argued or advocated. Yet there are many shops at the present time so constructed that some kind of an artificial light is needed all through the day, and in some at nearly all seasons of the year, and this condition prevails over a considerable part of the working space. The result must necessarily be that both the quantity and the quality of the work done is below the standard while the health and the eyesight of the employees are both unnecessarily impaired, since sunlight and fresh air are two very important elements necessary to the health, activity and usefulness of the human family. Ofttimes the

evil results from a lack of consideration or appreciation of these necessities, and sometimes perhaps from a false idea of economy on the part of those having charge of such matters, which has led them to provide very indifferent substitutes for sunlight, or, in its absence, a proper artificial light. For it is true, "and pity 'tis, 'tis true," that in some shops, even in this enlightened age, many hours' work is done by the smoky glimmer of dirty oil lamps, these relics of a bygone age, since they are not many steps in advance of the vessels of oil with their fibrous wicks resting against one side, used in the days of Abraham, 1920 B. C. Although the common use of petroleum oils in various degrees of refining have revolutionized the old-time lamp, and the simplifying of the processes for generating and purifying illuminating gas have produced two very useful illuminants within the reach of nearly everyone, they will probably never regain the position which they lost when the practical utility of electric lighting became a recognized fact.

The one great drawback to all artificial means of illumination is that to produce light we must generate heat; and hence, however we produce light, whether by the combustion of oil or gas, or by the generation of an electric current, to form a brilliant arc, or a glowing incandescence, we must necessarily waste a large percentage of energy in producing heat which we do not want and which is often a very serious objection. We shall therefore not have the perfect light until we have been able to produce the illumination we desire without generating heat. Whether we shall ever realize that much-sought condition is a question for future development and invention to demonstrate.

In the application of the electric light in manufacturing operations we have the choice of the arc lamp and the incandescent lamp. Both have their objections as well as their merits. The arc lamp, being much more powerful and projecting its rays a much greater distance than the incandescent lamp, is well adapted to illuminating large areas, where there are comparatively few obstructions. In confined situations, or where there are many obstructions it produces disagreeable shadows, and its glaring brilliancy is hurtful to the eyesight of the workmen. Translucent globes or shades may be used, of course, but these devices necessarily reduce the illuminating power of the lamp. Again the arc lamp is not readily moved from place to place, even short distances, so that the workmen must often stand literally "in his own light."

The incandescent lamp gives a much softer and more agreeable light to the eyes of the workmen, who may work many hours by its aid with less discomfort than by almost any other light. It is also much more portable than the arc lamp, since it may be provided with flexible conducting cords of any convenient length, and hung up or held in the hand in the most desirable positions. Still another convenience of the incandescent lamp is that of being able to locate a permanent magnet in the base of it, by which means the lamp is retained in any desired position by simply placing it against any iron or steel surface. This is a matter of great convenience when working in dark corners or making repairs under machines, where the usual fixed lights are of little use and where ordinary incandescent lamps must be held in the hand; and also in awkward positions such as are frequently found during the work of erecting heavy machinery or repairing it. These convenient characteristics of the incandescent lamp render it valuable for practical use in the machine shop. It may be readily placed in confined situations where an arc light could not, and it may be used much nearer the eyes of the workman without injury.

It would therefore seem wise, in devising a system of artificial lighting, to avail ourselves of the advantages offered by both the arc and the incandescent lamps, each in the places where their special merits can be made use of. Both types of lamps may be operated by the current from one dynamo, by the use of proper transformers, but it will usually be found more practical to put in a dynamo specially designed for each system. Ample space has been provided in the engine room for dynamos for this purpose, as well as for furnishing the necessary current for operating the traveling crane in the machine shop and the power required in the foundry.

In the machine shop the clear space needed for the traveling crane precludes the suspending of arc lamps through this central portion, but they may be placed between and a little inside of the line of the columns. They should be about 50 feet apart, which would require 14 lamps on the main floor. In addition to these a sufficient number of incandescent lamps should be provided to accommodate the individual needs of the men operating machines, wherever such additional illumination is necessary from the location of the machines and the character of the work. They should also be provided at the small tool-distributing room and in the foremen's offices, and a number should also be hung upon the columns, having sufficient length of conductor cord attached to them so that they may be used in erecting machines in the central space.

From the character of the machines employed and the work done in the galleries the incandescent lamp will be the most suitable. There should be at least one to each machine and in the case of long lathes one to every ten or twelve feet of bed. A lamp should also be hung at the head of each stairway.

The large open space of the foundry may well be provided with arc lamps, four of which will be sufficient, supplemented by a few incandescent lamps with long cords hung on the columns, for use in deep molds and similar places left in darkness by the arc-light shadows. The chipping and pickling room will require one arc lamp and several incandescent lamps, all provided with wire nettings for protecting them from flying chips. The core room, wash room, foreman's office, water closets, the space under the cupola platform, etc., will require incandescent lamps.

The forge shop will be best served by two arc lights in the main part, and by incandescent lamps in the foreman's office, wash rooms, water closets and perhaps in the bar stock storage space. One arc lamp in the storehouse and one in the carpenter shop, with perhaps two or three incandescent lamps in the latter, will be sufficient.

The boiler room will require an arc lamp hung over the tram track so as to fully illuminate the boiler fronts, and two or three incandescent lamps convenient to the space in the rear of the boilers and in similar places. The same number and kind of lamps will answer for the engine room. The adjoining wash rooms and water closets should be provided with incandescent lamps, say four in each of the former and three in each of the latter.

An arc lamp erected on a pole 20 feet high should be located in the yard between the foundry and the power house and about 35 feet from the machine shop. A similar one should be placed in the center of the space between the storage sheds, carpenter shop, power house and the forge shop. These will greatly facilitate yard work near the close of the short winter days.

The entire front building, including the offices, tool rooms, pattern shop, pattern storage loft, drawing room, etc., should be lighted by incandescent lamps, those in each room being arranged to suit the peculiar conditions in each case, as to the kind of shades and reflectors employed.

To equip the entire plant as described above will require, say 27 arc lamps and 267 incandescent lamps, the latter number being somewhat lessened or considerably increased according to the character of the machinery to be manufactured, as whatever change in this respect is made would most likely affect the incandescent lamps and possibly the arc lamps as well.

In providing for the amount of current necessary to supply this system of lighting we should make allowance for any possible increase that may be called for by unforeseen circumstances, or by a change in the products of the concern, and it would usually be safe to add for this purpose at least ten per cent.

The power necessary to run the dynamos with the added ten per cent. will be about 30 horse power for the arc lamps and 20 horse power for the incandescent lamps, or a total of say 50 horse power to be provided for, in calculating the capacity of the proposed engines.

By referring to the general plan drawing published in this series in the October, 1902, number, the arrangement of the lamps as herein described may be readily understood.

PISTONS AND PACKING RINGS.—3.

J. H. DUNBAR.

A friend has called my attention to an unintended omission in the first of these letters, of his favorite, the Corliss piston. While it is out of the question to show all the various pistons made, it was an oversight to neglect one so popular as the Corliss. Figs. 1 and 2 show my friend's preference of pistons.

The Corliss piston as I have seen it made, consists of a spide, follower, a T-bullring and what is practically a single packing ring, together with the necessary studs and setscrews. Fig. 1 is an end view of the top part of the piston as it would look if the follower was removed, and the T-ring faced off flush with its groove for the packing ring. Fig. 2 is a vertical section through the center of that part of the head shown in Fig. 1.

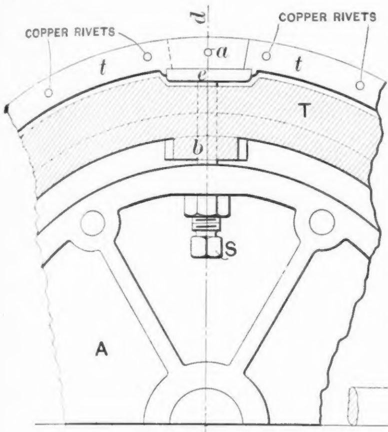


Fig. 1.

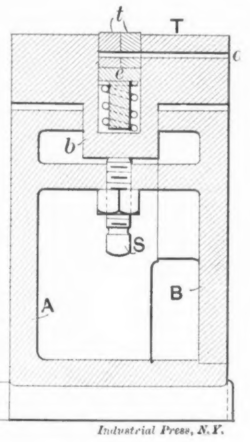


Fig. 2.

The follower and spider form a groove in which to grip the stem of the T-ring, which can be adjusted to keep the spider in the center of the cylinder by the setscrews striking the hub *b* on the ring. The T-ring, besides having a groove for the packing ring has radial holes drilled down to the hubs to receive a helical spring made of German silver, and the stem of a cover piece, marked *e*. Two packing rings are made and cut into eight sections usually, then riveted together so they will break joints when they are placed in the groove; the cover piece fits under these joints and stops any leak that would otherwise be there. They also set the packing ring out to the cylinder and keep it from revolving in the groove. The small holes marked *a* are drilled through one end of the T-ring and through the packing ring at its joints. Wires in these holes hold the packing ring in the groove while the piston is put in or taken out of the cylinder. If the ring is considerably worn the wires cannot be used in taking the piston out. A piece of sheet iron should be put in the counterbore to keep the ring from springing into the port as the piston is taken out of the cylinder.

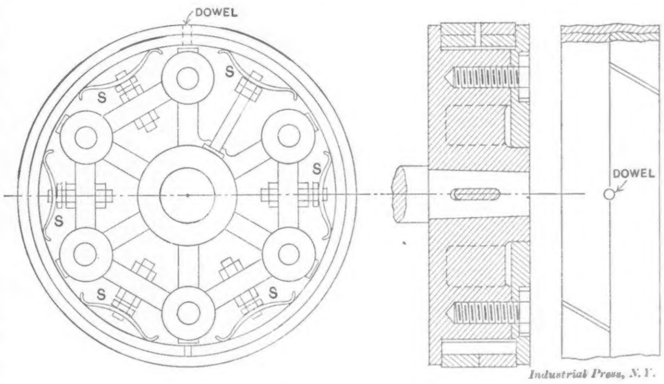
My recollection of these pistons is that they were hard on the bottom of the cylinders. There was a generous amount of wearing surface on either side of the packing ring and the steam load on top of the T-ring should have held it to the bottom of the cylinder, to some extent at least, in proportion to the area of contact and the steam pressure; thus producing an unnecessary amount of friction and consequent wear. This piston may be very much simplified by making it in one piece, and while there would be no means for vertical adjustment to compensate for wear there are no parts to get loose, and first cost is reduced. Again an engineer cannot "monkey" with it, and with the vibrating rod-packing there is not the necessity for exact piston adjustment there used to be. The packing ring, *per se*, is an excellent one. It has plenty of radial stock to wear away before a new one is required on that account, and it is an important thing to leave two wearing surfaces, when they get properly "skinned," alone as long as they can be. Its radial depth minimizes groove wear and also steam leakage around the ring. From a standpoint of intrinsic worth, based on its chances for long life and effectiveness, it certainly heads the list. The Corliss piston and packing ring do not seem to be well mated. The efficiency of the ring is handicapped by the anti-efficiency of the head.

There is no rule that I have seen by which to determine the size to make the piston head. Of course it must be some smaller than the cylinder, even if both are the same temperature. If pistons are made 1-64-inch to the foot smaller than the cylinder it will allow the piston to get 200 degrees F. hotter than the cylinder without sticking. I cannot think of any condition calling for a greater allowance for difference in the two diameters.

There is another piston, quite different from any that I have spoken of, which has done excellent service, and was popular forty years ago. "Three-ring packing" is the only name I knew it by, and I take it that the reader is more interested in the detail itself than in the history of it. There are lots of pistons made now with three or more rings in them, but the piston to be described is in a class by itself, and represents the practice of, say fifty years ago. It is shown in Figs. 3, 4 and 5. It consists of two outside packing rings and one inside, which is as wide as both outside ones, a spider, follower plate, bolts, setscrews and elliptical springs. Fig. 3 is an end view of the piston with the follower taken off. Fig. 4 is a vertical section through the center of the piston, after the follower has been replaced. Fig. 5 is a plan view of the rings showing how they are cut and doweled to keep them in that relative position.

The packing rings were turned the size of the cylinder, or if there was any difference, slightly larger. The elasticity of the elliptical springs *s, s, s, s, s, s,* were depended on to keep them set out to the cylinder to compensate for wear. In the larger sizes a bar was cast across from bolt boss to bolt boss, which made the spider much stronger than it would be without them, and also came handy to support the setscrews. For the smaller pistons, these bars were omitted and setscrews with T-heads were used, which were fitted in a slot in the hub of the spider. Both styles are shown in Fig. 3. The spiders that were bored, tapered and keyed to the rod seldom came loose, but they were the exception. The pistons I refer to were used in engines driving saw mills in the timber districts of Ohio and Indiana.

The engines were with few exceptions, between 7 and 14 inches in diameter, and generally short stroke, say 8x10 inches. The small engines were direct connected, that is, the engine crank was on one end of the shaft, and about a 66-inch circular saw on the other end.



Figs. 3, 4 and 5.

These would now be called "unit" mills. The others were belted from a pulley on the engine shaft to a smaller one on the saw mandrel. The unit mills had the preference, because they could be moved in the woods easier than the other kind, and in either case it was easier to move the mill than the woods. The mills were run only in the winter, or rather, when farm-work could not be profitably done; hence a mill crew was liable to get scattered during the summer, and it was not unusual to make an engineer out of a boy who the winter before had worked at logging. This way of making engineers was a good thing for machinists sometimes. I will, with the editor's permission, keep on digressing, and relate an instance.

My boss sent me out to fix up a mill where the only trouble was that they could not keep up steam. This might be caused by wet slabs and saw dust, a hole through the side of

the chimney, a very dirty boiler or flues, or rain falling on the exposed boiler. Then the conditions of the engine or mill might be factors in the problem to be considered. To some it might not be thought fun to ride seven or eight miles in a wilderness on a log wagon, drawn by a yoke of oxen, and most of the way over a new road which was sixty-nine per cent. stumps, the balance corduroy. I did not enjoy the prospect myself, and the boss, quick to guess that I had a kick coming, side-tracked it by saying that it would be some easy job; it would be a change and give me an opportunity to exercise my ingenuity and skill, etc., but the taffy that stuck was that I should get a dollar a day extra while I was gone.

When we got close to the mill, I thought that I had located the trouble, judging by the sound which came from the top of the exhaust pipe, which was more of a roar than a lively succession of puffs, as it should be. The first thing done was to stop the engine in a position when the slide valve would cover both steam ports. Then the throttle was opened, but no steam was seen to escape from the exhaust pipe, showing the valve to be O. K. The piston was next tested by shutting off the steam, turning the engine on the quarter and hooking a tooth of the saw over a crowbar placed on top of the saw guide to hold the engine in that position, then opening the throttle again. It was not necessary to go out to look if the steam was escaping; it could be heard blowing through, or past the piston. I had expected then that a spring bolt had got free and pounded a hole through the spider and follower, as was sometimes the case, and let the steam blow through the holes. I was mistaken, however, and most happily so too, for in that case it would have necessitated another trip, which was barely to be thought of in my shaken-up condition. The trouble was caused by the jam-nuts working loose and letting the packing rings down. It was but a short job to re-set the rings and make the several parts of the piston as secure as possible.

A search for further trouble resulted in not finding any; then the mill was started and went off just as though nothing had happened. Right here I want to say that it was a standing order in that shop that the first thing a man must do after shutting an engine down was to make a personal inspection of the safety valves, and I believe it a duty every one who is called to work at isolated steam plants should perform. Of course this is unnecessary where competent engineers are employed.

About three weeks later I was sent to this same mill to remedy the same trouble as before, with this positive injunction, "to set that packing out so it would stay set." No taffy this time; just plain, every-day business. When I got there I learned that the "engineer," in hopes to stop the leak at the top of the exhaust pipe when the engine was running, had set the packing out every night as soon as the mill was closed. He was evidently acting on the general principle that if a little set was of such great good more of it would be better. Up to this time there was a question in my mind as to whether I ought to return the extra dollar which I had received for the first trip. Well, the information which I have just related as to the cause of this trouble put a quietus on that doubt, and gave assurance that my time put in on this trip would be at the same rate of pay as on the former one.

On removal of the follower I found but little left of the outside rings, and that the dowel pin in the inside ring had scored a groove in the top of the cylinder which one could lay a finger in. We got the cylinder off the bed-plate that night and loaded on the wagon ready for an early start for the shop in the morning, where the trouble was remedied by boring the cylinder and making a new piston complete. Incidentally, I remarked to my foreman, after explaining to him how it happened, "that I hoped he would succeed in making the new set of packing so it would hold together longer than three weeks." He replied that he would do his best to make the new rings "fool proof," and he succeeded to an extent much greater than he had expected. He made the outside rings as before, but the inside one he had made enough larger to set the outside ones out to the cylinder, and also had it made eccentric, so its pressure would be more uniform on the other rings. Two springs and their setscrews were used at the bottom to raise the head with, as the rings wore down. The others were left out, making a piston of fewer pieces and practically as good.

As a moral, I want to say that just because a young fellow makes a big mistake at the start, it is no proof that he is going to keep at it all his life. That all depends on the kind of stuff he is made of. The boy in question not only learned how to make a success of running an engine, but also lathes, planers, etc., and then became a mechanical engineer.

* * *

STRENGTH OF COUNTERSHAFTS

FRANK B. KLEINHANS.

There is scarcely a shop in existence which has not had a more or less serious accident from a countershaft some time in its history. It may have been caused by a heavy pulley running very much out of balance, or the shaft may have been bent in the beginning. Possibly the shaft was too light, or too long between hangers. The latter is responsible for most of the trouble, and is the one with which this discussion is principally concerned.

There are two methods in vogue for turning cones and pulleys; one is to set the rough casting to run true on the inside, and the other on the outside. This latter method makes a cheaper and an easier job, but when turned it requires an enormous amount of metal to balance it. And here is the source of considerable trouble. You may balance a large cone perfectly on straight edges, but that is a standing balance only; and when the cone is put in place and speeded up to several hundred revolutions per minute, it shakes, and shows that it is decidedly out of balance. The trouble is you have not placed the balance weight directly opposite, or in the plane of the heavy portion of the cone. The result is that neither weight, when rotating, has its counterweight pulling in the same line, and of course the pulley is sure to be out of balance. All cones and all other pulleys which have a wide face should be set to run true on the inside before turning.

A certain countershaft failed because it had been welded near the center. The weld twisted and bent open, and some one was badly injured by the fall. A weld in machine steel is so very uncertain that it should never be trusted for such a purpose. The extra expense of a new shaft would not warrant the hazard of such a risk.

Another countershaft failed in what was, at the time, considered a mysterious manner, as the shaft was strong enough to resist either bending or torsion. The trouble was that shaft was that it had too much spring. The countershaft was loaded with several heavy pulleys, and the irregular pull of the belt set the shaft to vibrating. Each little impulse was added to the other, and this being increased by the momentum of the moving mass of the pulleys, finally caused the shaft to fail.

In the calculation which follows the spring of the shaft is limited to .06 of an inch. There are plenty of counter shafts which have been running for years with about this much spring. Now, from the general formula for the deflection of a simple beam, we have:

$$\text{The deflection, or spring} = \frac{W L^3}{48 E I}$$

In which W = the load at the center in pounds.

L = the length between center of hangers in inches.

E = the coefficient of elasticity = 29,000,000.

I = the moment of inertia of the cross-section of the shaft.

For a round shaft,

$$I = \frac{\pi d^4}{64} \qquad (1)$$

In which d = the diameter of the shaft in inches.

We then have:

$$\frac{W L^3}{48 E I} = .06 \qquad (2)$$

From 1 and 2,

$$\frac{64\ W\ L^3}{48\ E\ \pi\ d^4} = .06$$

$$L = \sqrt[3]{\frac{.06 \times 48\ E\ \pi\ d^4}{64\ W}}$$

$$= \sqrt[3]{\frac{.06 \times 48 \times 29{,}000{,}000 \times \pi}{64} \times \frac{d^4}{W}}$$

$$= \sqrt[3]{4{,}100{,}000\ \frac{d^4}{W}} \ldots\ldots\ldots\ldots\ldots (A)$$

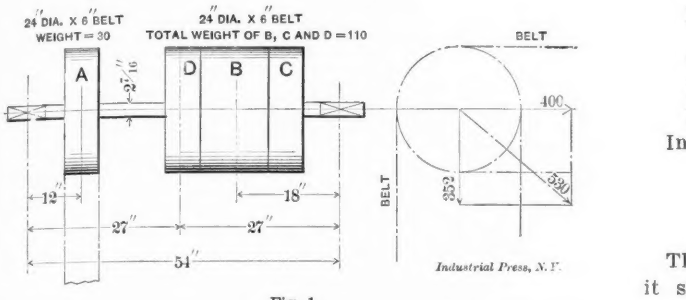


Fig. 1.

Fig. 1 shows a countershaft which is in actual service and which we know is all right. *A* and *B* are keyed to the shaft. *C* and *D* are loose pulleys arranged for open and cross belts. *A* weighs 30 pounds, and *B*, *C* and *D* weigh 110 pounds. The belts run as shown in the figure. If *A* weighs 30 pounds and the centers of the hangers are 54 inches, then by taking the left hand hanger as the center of moment, we have $30 \times 12 = x \times 27$, when x is the weight at the center. Solving we find

$$x = \frac{30 \times 12}{27} = 13$$

In the same way, by taking the right hand hanger for the center moment, we find that

$$x_2 = \frac{110 \times 18}{27} = 73$$

As to the belt pull, it is possible for a single belt to run up to 70 pounds per inch of width of belt, and a double belt can be taken at 100 pounds. As a double belt is used in this case, and as the slack side of the belt is very loose when the tight side is pulling its maximum, we will take the pull at the pulley, $A = 6 \times 100 = 600$ pounds, and getting this in terms of a load at the center, we have

$$x_3 = \frac{600 \times 12}{27} = 266$$

the downward pull is $13 + 73 + 266 = 352$.

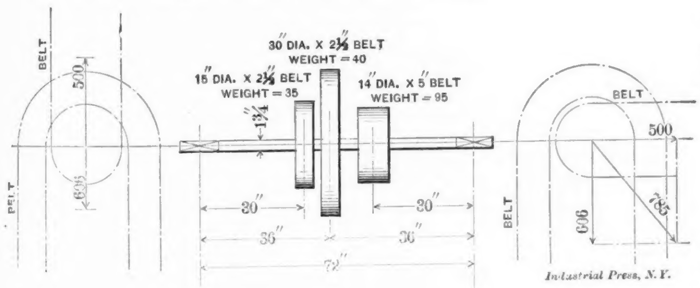


Fig. 2.

The pull at the pulley *B* will be $6 \times 100 = 600$, and by transferring this to the center we have

$$\frac{600 \times 18}{27} = 400$$

The resultant of these two forces will be the diagonal of the force diagram, and is equal to 530 pounds, which is equal to W in the formula. Introducing these terms in equation (A) we have

$$L = \sqrt[3]{4{,}100{,}000\ \frac{(2.44)^4}{530}}$$

and by solving we find $L = 65$, which means that for this condition of loading the countershaft would be safe with the hangers 65 inches apart.

Fig. 2 represents another countershaft taken from actual service. It is belted as shown on the left hand view, and is running all right, although it looks rather flimsy and one would consider it unsafe. Taking the moments of the weights of the pulleys and belt pull about the right and left hand supports, and finding the equivalent pull at the center, we obtain:

Weight at center due to pulleys =	148
Pull on 30-inch pulley, $2\frac{1}{2} \times 100 =$	250
Pull on 15-inch pulley, $2\frac{1}{2} \times 100 = \frac{250 \times 30}{36} =$	208
Total downward pull =	606
Pull on 14-inch belt, 5×100 upward pull =	500
Resultant downward pull =	106

Introducing this value of W in equation (A) we have,

$$L = \sqrt[3]{4{,}100{,}000\ \frac{(1.75)^4}{106}} = 71.3$$

This is practically the distance at which it is running, but it shows that it is the greatest distance apart at which it would be safe to place the hangers. If the belts ran as shown in the right hand side of Fig. 2, we would then have:

Weight due to pulleys (as before) =	148
Pull on 30-inch pulley =	250
Pull on 15-inch pulley =	208
Total downward pull =	606
Horizontal pull on 14-inch pulley, $5 \times 100 =$	500

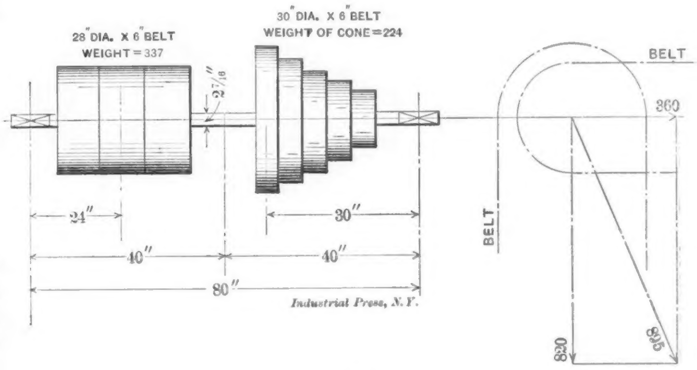


Fig. 3.

From these two forces we find a resultant of W = 785. Substituting this in (A) and solving as before, we find L = 37, which is the greatest safe distance between hangers for this condition of loading.

There are cases where one must have an extra long shaft in order to work in the pulleys, cones, etc., as shown in Fig. 3. Here the downward loads amount to 820 pounds, and the pull at right angles amounts to 360 pounds. The resultant, 895 pounds = W.

Introducing in the formula we have

$$L = \sqrt[3]{4{,}100{,}000\ \frac{(2.44)^4}{895}} = 55$$

This means that for this condition of loading, the center should not exceed 55 inches, and since in this particular case it could not be made as small as this, the pulleys should be arranged to accommodate a third hanger.

In every case, therefore, where the centers are so far apart as formula (A) would indicate to be unsafe, a third hanger should be used. If all the flimsy countershafts had a third hanger added to them there is no doubt but that the number of accidents would be greatly diminished. In the above calculation the weight of the countershaft has not been considered, as it is usually very small. If the belts run at any other angle than that shown, the construction is made in exactly the same way, using the required angle instead of a right angle, the resultant of the two forces being used as W in the formula.

NOTES FROM MANCHESTER, ENGLAND.

Editor MACHINERY:

Some account of events and developments during the past year in the Manchester (England) district may be in order.

An interesting item was the inauguration of the Manchester Municipal School of Technology, by Mr. Balfour, the British Prime Minister. This institution is splendidly equipped in every department, and is considered one of, if not the best, in Europe. Mr. Reynolds, the principal, is, however, much troubled at the fact that British employers have not yet accustomed themselves to the idea of utilizing the services of the graduates by placing them in such probationary posts as will admit of their adding the concrete training of the works to the more or less abstract—though desirable—training provided by the school. However, there are signs of a change for the better in this respect, the President of the Manchester Association of Engineers, in his inaugural address having recently pleaded for more patience with the shortcomings of the college students, in consideration of their potential value; and some employers, at least, are considering how this particular class of ability can best be availed of.

A valuable addition to the defensive forces of the country—judging by the fine record of the Crewe, electrical and other volunteer engineers in the recent war in South Africa—takes the form of a volunteer engineer battalion raised in the Manchester district—the School of Technology having been prominent in raising recruits and being about 500 strong. Very instructive training in the way of military bridge building and other field work has been imparted during the summer months, and it is hoped to raise an additional company from the staff and workmen of the British Westinghouse Co., whose works are now getting fairly into swing.

One immediate effect of the establishment of this concern is to cause the services of efficient toolmakers to be at a premium. All the better. In conjunction with the engineering department of the local School of Technology, the Council of the Manchester Association of Engineers are conducting a series of experiments, with a view to ascertaining more definitely than is the case at present, the relative merits of the new high-speed cutting tool steels, as compared with the general run of crucible cast tool steels. A specially powerful lathe has been lent for the experiments by Messrs. Armstrong, Whitworth & Co., and the results of the trials will be published in the transactions of the Association.

The new Education Act, which comes into force very shortly is a decided step in advance in many ways. It provides for more efficient staffing and supervision of primary and secondary schools; and the manner in which the municipal and other local governing bodies are setting to work by appointing committees to carry out the Act, representative of scholastic, administrative, and industrial experience, augurs well for the educational equipment of our future workmen and industrial directors.

A visit, which has, no doubt, attracted attention in America has been taken part in by representatives of a number of British trade unions. Mr. Alfred Moseley, a London merchant, offered to bear the expense of a visit to the principal industrial centers in the States, the idea being to provide an opportunity of comparing the manufacturing methods and labor conditions of the two countries. Reports from the delegates are just appearing, and though credit is given for many valuable American features, it is not considered, on the whole, that the American worker is really better off than his British compeer. According to the Cotton Trade representatives, cotton mills in the southern states are reproducing many of the most objectionable features of the first period of factory life in England—that of child labor. Alabama and Georgia are particularly reprehensible in this connection.

The Northrop loom, as manufactured by the Draper Co., of Hopedale, Mass., was the subject of special investigation, and though it is considered that little would be gained in Lancashire by its sudden adoption, it is recognized that looms built on analogous lines, and worked on a somewhat identical system will probably need to be gradually introduced, and modified to suit local conditions and markets. Mr. T. M. Young, who recently contributed a series of interesting articles on the American cotton industry to the Manchester Guardian, reported a case where makers of automatic looms executed an order for 1,000 machines, taking the non-automatics in exchange. It was pointed out as an economic curiosity, that whereas the early cotton operatives smashed newly-invented machinery to prevent its displacing the old, the old looms in this case were smashed before leaving the mill, by the makers of the new, so that they might never come into competition with their own make.

Touching on conditions in engineering workshops, and daily life, in the States, Mr. M. Arrandale, secretary of the United Machine Workers—planing, drilling, milling, etc., machine operators—reports as follows:

The American worker receives much higher wages than we do in this country, but, on the other hand, the necessities of life cost much more; house rent and railway traveling are much dearer; food in many cases is also much dearer; more money is spent by the American worker in amusements, and domestic life altogether is not nearly so comfortable as in this country. Referring to works visited in one city, Mr. Arrandale declares they were carried on "under about the worst conditions that men could be found to live in, if living it could be called. I found traveling cranes running from end to end of the place, in some cases carrying enormous weights, not always slung in the safest manner. It is no uncommon occurrence for half a dozen men to be injured or killed by the weights falling, almost every day." Again, "some employers in the States seem to value their machinery a great deal more than their work people. I also found through the whole of the country that there is not the slightest regard for life or limb. The human being is often looked upon as of no value and to be more easily replaced than the machinery." He sums up as follows: "The lot of the worker in this country is equal to, if not better, than in America.

Recent additions to the engine and machinery manufacturing facilities of this district include large extensions to the works of Mather & Platt; Armstrong, Whitworth & Co., etc.; while Trafford Park has received additions in the shape of the new branch works of Messrs. Royce, Ltd., electrical engineers.

Large orders for locomotives have been received by Messrs. Beyer, Peacock & Co., Ltd., and on the whole there appears good reason for believing that the Manchester district will long remain the center of an important and far-reaching engineering industry.

JAMES VOSE.

Manchester, Eng

* * *

THE INFLUENCE OF COST ON MACHINE DESIGN.

The *Mechanical World*, in commenting on engineering text-books, ancient and modern, says that there are a few good books on the steam engine and its design, but intimates that not one of them indicates the comparative cost and time of production of the component parts, or the comparative cost of different types of engines of the same power. The same fault exists in the teaching of the technical schools. The belief is expressed that not one student in a hundred has any notion beyond a mere guess of the comparative cost of the different parts on which he devotes so much study. Neither is he in a position to estimate, say, whether a reduction of one-half inch in diameter of an engine crankshaft would allow the use of nickel steel in place of mild steel without increased cost, nor does he know whether the valve gear is worth five, ten or twenty times the same weight of bedplate metal. The writer believes that while it is undoubtedly unpractical to make estimates of the actual commercial costs of engines or other examples of machine design, in engineering schools and text-books, it is possible to give the students an idea of the relative costs of the component parts of any machine. Armed with this knowledge the young engineer is better equipped to calculate costs in actual engineering work since he may to a certain extent use his theoretical costs and multiply them by such coefficients as the conditions of labor and material cost may seem to indicate. It is pointed out that the question of cost alone, has a vital influence on machine design itself, aside from theoretical considerations. For instance, the young student designer should be in a position to know whether, say, a complicated steel piece that requires considerable machine work will not be more expensive and no better than a simpler and heavier cast-iron piece, etc.

NOTES ON POWER AND TRANSMISSION.

In an address before the Washington meeting of the Association for the Advancement of Science, held in midwinter, Prof. J. J. Flather reviewed some of the important features of recent progress in the field of power and transmission, taking up electrical development, gas power and compressed air. The following notes on electrical transmission and gas engine practice are abstracted from the address:

The labor cost in machine shops is so much greater than the cost of power that any expedient by which the former may be appreciably reduced is justified, even though the efficiency of the agent itself is low. While the efficiency of electrical transmission is not the essential, so essential is the efficiency of the tool in turning out work, comparative figures upon cost of transmission are not without interest. Prof. Flather says: The percentage of loss due to shaft friction in railroad and other shops where buildings are more or less scattered may be 75 per cent. of the total power used. In two cases known to the writer, these losses were 80 and 93 per cent. respectively, and in the ordinary machine shop they will probably average from 40 to 50 per cent. In view of these losses there is a general tendency towards hollow and lighter shafting, higher speeds and lighter pulleys, roller bearings in shaft hangers, and the total or partial elimination of the shafting, through the use of electric motors, either for independent or group driving.

A modern shop generator belted from an engine will have an efficiency of about 90 per cent. when working under favorable conditions, but as the average load is ordinarily not more than two-thirds full load, and often much less, the efficiency will not usually be more than 85 per cent. Since the engine friction was included in the figures above, so also it should be considered here, in which case the efficiency of generation will lie between 75 and 80 per cent. With a three-wire 220 volt system, which is very suitable for ordinary shop transmission when both light and power are to be taken off the same dynamo, the loss in transmission need not be more than 5 per cent., so that the efficiency at the motor terminals will not be far from 75 per cent. With motors running under a nearly constant full load the efficiency of motor may be 90 per cent.; but with fluctuating loads this may fall to 60 per cent. at quarter load.

Where cheap fuel is available it is found in most cases that electric power can be generated at the works more cheaply than it can be purchased from a central station; especially is this the case if the exhaust steam be used for heating purposes. In isolated plants the cost of transmission is very small as compared with the total cost of generation; whereas in the average central station the cost of transmission, which includes interest and depreciation on pole line, usually constitutes a large percentage of the operating cost. In those localities where the cost of fuel is high electric power can often be purchased more cheaply from a central station which obtains its power many miles distant and transmits it electrically to a convenient distributing center, where it is used for power and light. The possibility of electrical transmission thus permits of the utilization of available sources of power at great distances from the center of distribution; but while it is interesting to know that a certain amount of power may be transmitted a given distance with a high degree of efficiency, it is more important to know whether the same amount of power could be obtained at the objective point more economically by other means.

PRESENT STATUS OF GAS ENGINE PRACTICE.

The gas engine, in large and small sizes, has reached a point where it can fairly rival the steam engine in reliability and satisfactory running qualities. In point of fuel economy a gas engine of moderate size is on a parity with the largest triple expansion steam engines and it will give a horse power on one pound or less of coal. But the price of gas is so high in this country that the gas engine has been used more on account of its convenience and saving of labor than because of its high efficiency. It is true that natural gas is cheap, but it is equally true that natural gas is not generally available. Fortunately the manufacture of producer gas has reached a high state of development. The leanness of producer gas renders it less effective per cubic foot of gas, as compared with the richer coal gas, or even water gas, but this difference is more than compensated for by the low cost of production. It is upon such power gas that the commercial future of the gas engine as a general motor depends.

The producers are very simple in operation and furnish a convenient and economical means of obtaining power at a much lower rate than with the ordinary city lighting gas. Generally small anthracite coal or coke is used, but several methods employ bituminous coal, lignites, or wood. With bituminous coal, means must be provided for removing the tar and ammonia, and other products of distillation.

The gas engine industry received a signal impetus when it was discovered that blast furnace gases could be readily utilized direct in combustion engines without the intervention of boilers and without any special purifying processes. A still more important circumstance is the fact shown by Prof. Hubert, of the Liege School of Mines, that the superior economy of the gas engine enables equal power to be obtained with 20 per cent. less consumption of furnace gas than was formerly used in the generation of steam.

The successful employment of large combustion engines in this way utilizes vast sources of power which a few years ago were allowed to go to waste or at most were used very inefficiently.

The high thermal efficiency of the gas engine has long been recognized, and the possibility of further development is a promising factor in this field.

Efficiencies of 30 per cent. or more have been obtained with blast furnace gases which contain a very small percentage of hydrogen, and this, with the high rates of compression which can be carried, has led to the advocacy of non-hydrogenous mixtures in large engines. Certainly very high rates of compression may be had with a non-hydrogenous producer gas without fear of premature ignition, and it has the additional advantage of economical production.

The practice of making the cylinder in combustion engines act alternately, first as air compressor then as motor, has the advantage of greater simplicity, but it means immensely larger engines for the same power, since the number of effective impulses is thus cut in two.

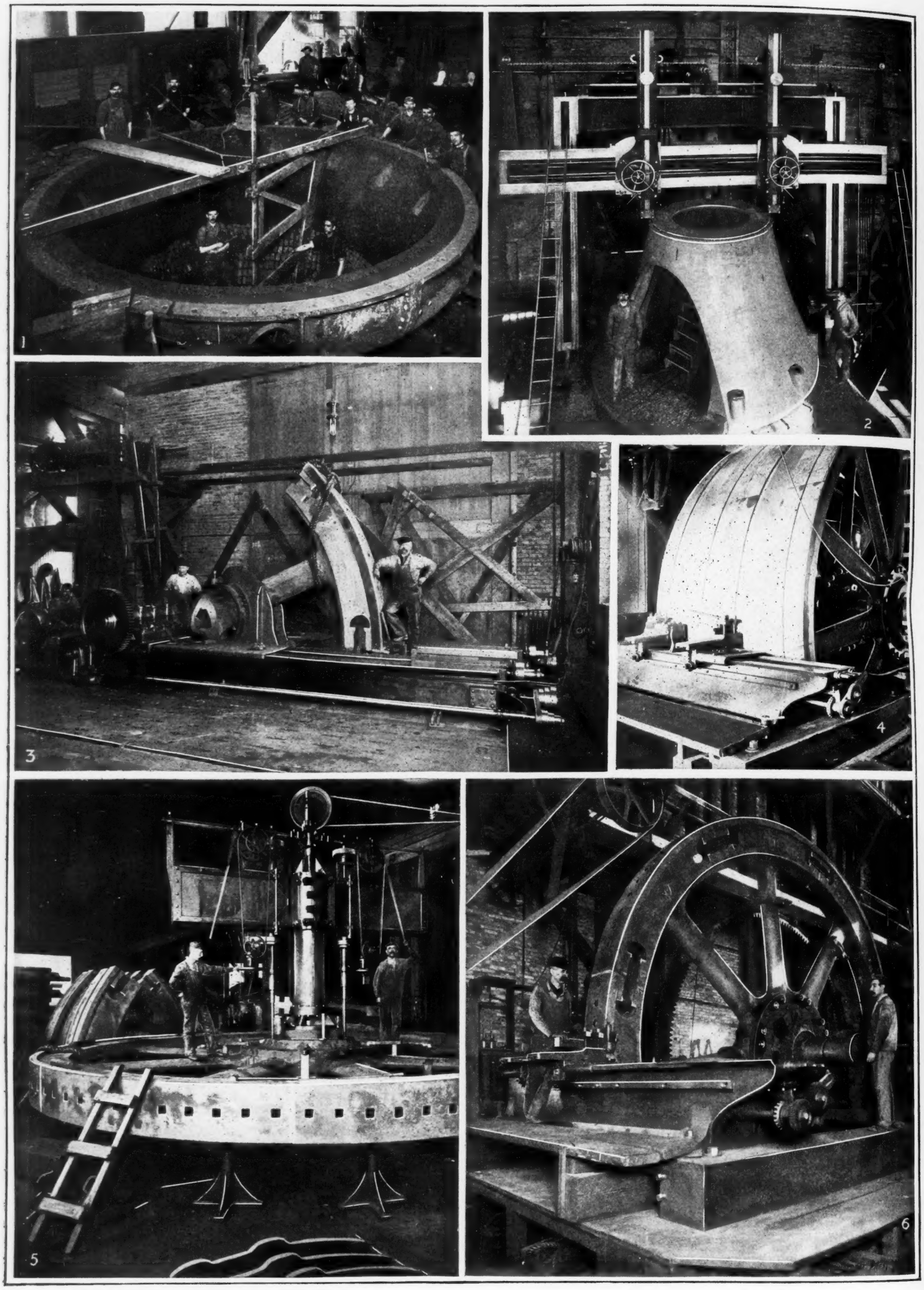
The danger of pre-ignition and consequent severe shock on the engine also necessitates very heavy construction in the larger engines in order to obtain a reasonable degree of safety in operation. Moreover, the smoothness of action is greatly retarded with this form of engine, especially if the governing is controlled by the "hit and miss" method, in which the regulation is effected by varying the frequency of the explosions, thus causing great variations in the driving torque.

Various expedients have been employed to overcome these defects, such as the use of multi-cylinders and different methods of control, but the size and cost of engines have been increased rather than decreased. Notwithstanding these well recognized defects in the 4-cycle type of engine, it constitutes by far the largest class in use to-day of what may be called successful gas engines.

Some recently very satisfactory results have been obtained in the construction of 2-cycle engines. In some of them we find separate pumps employed to compress the charge of gas and air, which ignites and burns as it enters the cylinder. Higher compression is thus obtained without fear of pre-ignition and this permits smaller clearance spaces with attendant advantages.

If the engine is single acting, an impulse is obtained every revolution, which thus insures better speed regulation as well as double the power for a given size cylinder.

The highest thermal efficiency yet attained, namely 38 per cent., has been secured with a 2-cycle type of engine, but whether these engines will be as satisfactory for small motors remains to be seen. It is possible that the greater complication of details in the 2-cycle types as compared with the simpler 4-cycle engine will cause the latter to continue to give the greater satisfaction, at least for the smaller sizes.



VIEWS FROM THE E. P. ALLIS WORKS (RELIANCE WORKS), MILWAUKEE.

1. Pit for Casting Vertical Engine Housings.
2. Housing for Vertical Engine, on Boring Mill.
3. Double Planer at Work on Fly-wheel Segment.
4. Twenty-four foot Drive Wheel in Pit Lathe.
5. Universal Radial Drill for Fly-wheel Work.
6. Twenty-four foot Segmental Fly-wheel in Pit Lathe.

VIEWS FROM THE MILWAUKEE PLANT OF THE ALLIS-CHALMERS CO.

Two months ago we published a description of the new West Allis plant of the Allis-Chalmers Co., near Milwaukee, with illustrations of the various buildings. Supplementary to this, the several views shown herewith of the Old Reliance Works of this company, on Clinton street, Milwaukee, will be of general interest. The Reliance works consist of a group of

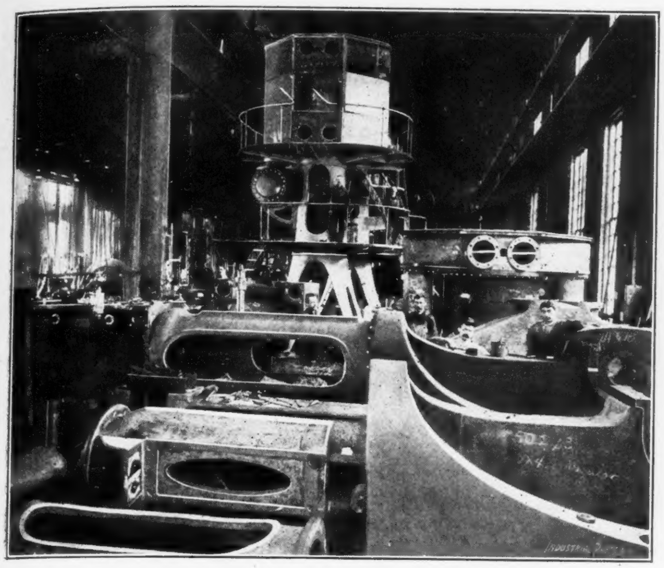


Fig. 7. General View of the Erecting Floor.

large brick buildings of a style of architecture in vogue several years ago, and while not strictly modern are reasonably well adapted to the needs of a concern building heavy machinery. If the present overcrowding can be relieved, through the removal of a considerable quantity of the work of the West Allis plant, they will be well adapted to manufacturing purposes.

It is in these shops that the immense engine-building business of the former E. P. Allis Co. was developed, under the able management of Mr. Edwin Reynolds; and the views shown indicate the manner in which some of the heavy work has been handled. Fig. 1 of the group shows the pit in which the housings for large vertical engines are cast; and in Fig. 2 is one of these housings on a 16-foot boring mill. Fig. 1 was taken when a mold for one of these housings had been partially swept up. Figs. 4 and 6 illustrate heavy work in

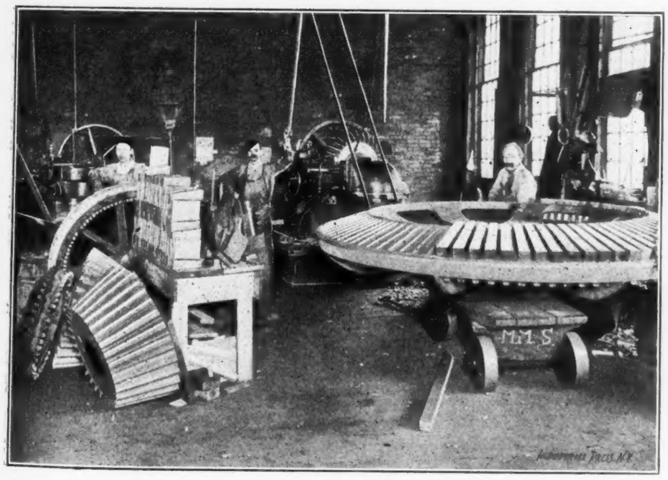


Fig. 9. Gear-making in Mill Department.

the pit lathe, that in Fig. 4 being a 24-foot drive wheel and that in Fig. 6 a 24-foot segmental flywheel. In Figs. 3 and 5 other work upon the segmental flywheel is being performed. Fig. 3 shows a double rotary planer facing off the sides of the arms to which the hubs of the wheel are bolted, and indicates clearly the manner in which the segments are secured to the bed of the planer, while the cutter heads traverse lengthwise of the beds and face off the casting.

In Fig. 5 a double radial drill is in use, for drilling and reaming the holes of the flywheel hub. This drill is of special design. It is supported by a column centered by the bore of the hub. Each radial arm of the drill is in the form of a double girder, between the two sections of which the drill heads are supported, so that they may be moved out or in for drilling holes on circles of different radii. The machine is rope-driven, as indicated.

Fig. 7 is a glimpse of the erecting floor and plainly indicates the need felt by the company for more extensive quarters which are now to be had at the new West Allis plant. Fig. 8 is another view of the 16-foot boring mill, with a large low-pressure cylinder in place for boring. A fixed boring bar is used, on which a cutter head is fed downward while the cylinder rotates with the table of the mill.

Besides the engine and mining machinery work for which the E. P. Allis Co. has been best known, they build an extensive line of flour and sawmill machinery and do general mill work of all kinds. Fig. 9 shows some of this work in prog-

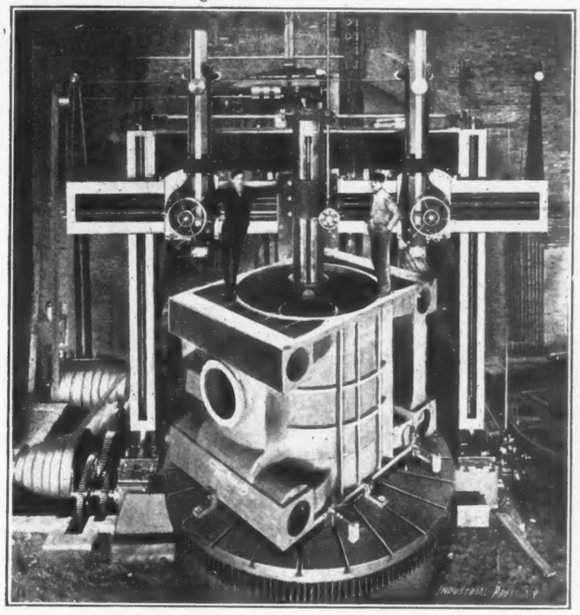


Fig. 8. Large Cylinder in Process of Boring.

ress in the mill department, where there are large bevel gears with wooden teeth in process of construction. These teeth are made by inserting hardwood blocks in spaces cast in an iron body and held by wedges driven in at the back in the usual manner for constructing such gears. The teeth are then shaped by a planing machine seen in the background in Fig. 9, in which the cutter is guided by a templet.

* * *

The chilled cast iron carwheel so generally used in the United States is undoubtedly the highest development of cast iron founding. Hundreds of thousands of cast iron wheels are in use under freight cars where they are subjected to the severest service imaginable, yet the proportion of wheels that fail before running, say, 60,000 miles, is quite insignificant. Heavier cars are imposing harder conditions to meet, however, and many railroad men have seriously questioned the advisability of using the chilled cast iron wheel for the heavier freight cars, believing that the limits of the chilled iron wheel had been passed. But, superior product as it is, the carwheel makers do not despair of still further improving it to meet the altered conditions of traffic. In a paper read before the November meeting of the Railway Club of Pittsburg, Mr. C. V. Slocum pointed out that the advances made in carwheel making since 1888 were great. He exhibited "test bars" 1 inch square and 12 inches long that had successfully stood a transverse load of 3,500 pounds; in 1888 the best test bars failed at 1,800 to 2,000 pounds. Experiments have shown that titanium in iron gives greater density to the metal, greatly increases the transverse strength, and gives a harder chill to the tread of the wheel. This latter condition seems quite remarkable when it is known that a broken fragment of the chilled metal of an ordinary carwheel will scratch glass, being as hard or harder than hardened tool steel.

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A WORD OF DISCOURAGEMENT.

Since answering "A. M." in the "How and Why" department of the last number upon the rotary engine question we have received a letter from another subscriber upon the same subject. Such letters of inquiry upon the advantages or disadvantages of rotary engines, their difficulties, the reason why rotary engines have not come into general use, etc., come to us with frequent regularity. In this instance the writer says: "For several years past I have devoted considerable time and attention to the problem of rotary steam motors or engines. As a result of my labors I have designed a machine of this type, and before taking any steps to secure a patent I desire to obtain some information in relation to the experience had by others in their attempts to solve the problem." Then follows a list of questions.

This correspondent is only one of hundreds of inventors who are now working on rotary engines and one of thousands who have worked upon them in the past. In view of the large number of patents that have been issued for "Engines, rotary," and the failure of practically all of them to net anybody any profit, except the patent attorneys and the United States government, we are constrained to offer the advice, "Don't take out a patent on rotary engines unless you can afford to lose the money you put into it."

Many people seem to think that the rotary engine is an unsolved problem, which thousands have been trying to solve without success and which will eventually be solved by some lucky fellow who happens to strike the correct idea; and so every inventor who has taken up the question has had visions of being the one man to reap the final success.

We do not look upon it in this light. What are the difficulties in the way of a satisfactory rotary engine? Mainly three. First that of unequal wear of the rotating parts, owing to their varying diameters; second, large clearance spaces and the supposed necessity for late cut-off; and third that to obtain a large amount of power the engine must either run at abnormally high speed or be excessively large in diameter. These difficulties do not seem insurmountable by any means, and there are probably several designs which remove the first two objections almost entirely. As to the last, high speed is not so objectionable now as formerly, in view of the developments in electric generators.

The whole trouble with the rotary engine "problem" is that there is no problem there needing solution. From the standpoint of the inventor it has been solved many times over. Amid all the worthless trash in the way of rotary engine patents that have been ground out in the patent office there have been a few having the elements of success and if properly developed would undoubtedly make satisfactory engines for certain purposes. There is a rotary engine made in Sweden that has proved quite popular for driving fans and other machinery of light power, and we have occasionally seen models of engines in this country that would undoubtedly run well and wear well and might prove very good motors. We believe that with all the time that has been spent in perfecting the rotary engine there is very little left for inventors to do and that further patents on rotary engines are not likely to net their inventors much if any greater returns than have those of the past.

Why then, have not some of these engine designs been sought out by investors and placed on the market? Not for lack of capital, for there has been plenty of money available for investment where there was a reasonable assurance of fair returns. If rotary engines would accomplish half what was claimed for them, there would be no trouble in financiering the project.

The only plausible answer to the question is that there has been no demand for rotary engines. The demand has existed in the minds of inventors only. There was nothing to indicate that a rotary would be any better than a reciprocating engine and people have let well enough alone and contented themselves with what was already giving good results. In the way of a ray of hope, however, it is only fair to say that the demand for engines of the rotary type promises to be much greater from now on because of the adaptability of such units for direct coupling to electric generators, a condition that did not exist a few years ago. But there is every indication that the turbine is better adapted for this purpose than the rotary engine, especially for large power, so that the "ray of hope" is not a very bright one and we see no reason for modifying the title of this editorial.

* * *

SHOP ACCIDENTS.

In the letter from our contributor, Mr. James Vose, published in another column, upon the industrial conditions in the Manchester, Eng., district, reference is made to the findings of the Moseley commission which recently visited this country and to which we have referred editorially. Mr. Vose quotes one of the members upon the iron-working industries of this country, who arrives at the conclusion that the workmen in England are on the whole as well off as workmen in this country. We have no disposition to question this because the arguments pro and con seem to balance up quite evenly. The machinist in this country earns more money and pays more for what he buys; presumably also he is able to purchase more things, though not necessarily things that add to his material comfort. The fact remains, however, that there is a certain pleasure in being able to handle money and to purchase articles, even though in the end one is no better off; and the result is that English workmen come to this country, like it, and make their homes here.

One allusion to the dangers to which American workmen are subjected and their liability to accidents in American shops, we believe in one way to be a just criticism and in another way, not. Probably precautions are not taken in this country to avoid accidents such as are taken in England; and it may be that in manufacturing establishments the percentage of those injured is greater here just as the percentage of the injured is greater in railroading. This is a point that should not be considered too lightly by manufacturers, as possibly it may be in steel and iron works and other places where a great deal of cheap labor is employed. On the other hand there is a very marked tendency to abolish labor in places where danger exists. The number of laborers employed in machine shops who handle castings or machinery is not nearly so great in proportion to the work turned out as formerly, and the very appliances that the representative quoted by Mr. Vose condemns, namely, the overhead traveling cranes, have done more to reduce the number of accidents than almost

any other one improvement. While the bustle and whirl of a modern machine shop are confusing to one not accustomed to American methods, the improved appliances for handling heavy masses are certainly a long step towards making the conditions safe for the machinist.

* * *

INSURANCE ENGINEERING.

Plans are maturing for a course in insurance engineering at the Massachusetts Institute of Technology. This will be brought about at the instigation of the Factory Mutual Insurance Companies and particularly of the Boston Manufacturers' Mutual Company. It is believed that the time has arrived when young men trained in the subjects of fireproof construction, fire hazards, the prevention of fire and kindred topics can do effective work in reducing the immense annual loss through conflagration. Edward Atkinson states that the ash heap in the United States in 1901 cost $150,000,000 directly, and $100,000,000 more through the expenses incident to conducting insurance companies, water works, fire departments, etc. This amount is considerably more than the annual appropriation for the public schools, and more than double the amount spent annually for colleges and technical schools —yet there is no school at present where the question of the prevention of loss by fire is taken and studied in a systematic manner.

An idea of what might be accomplished through such a department can be inferred from the records of the various companies of the factory mutual system of insurance. This system was organized 60 years ago, with the fundamental idea of preventing loss by fire among the different subscribers, through rigid inspection, the removal of fire risks and investigation of the causes of fire; and then paying "insurance" for such losses as could not be avoided by the precautions that were taken. It will be appreciated that this is quite different from the usual plan of insurance where, in too many cases, strenuous objections are raised by the owners of property to introduce safeguards; or at least, if these are adopted, it is done to "satisfy the insurance company" merely.

The mutual system was started among textile mills and has since spread to machine shops and other kinds of factories. It was found that heavy losses had been incurred through such simple causes as the breaking of watchmen's lanterns; the use of gear-driven instead of friction-driven fire pumps, in which the teeth frequently broke when starting; the use of animal insteal of mineral oils, leading to spontaneous combustion, and the common plan of constructing buildings with enclosed spaces in the walls under roofs, where fire could obtain headway unchecked, or rats' nests could be built of oily waste. Work was directed toward doing away with these and many other hazardous conditions, and statistics show that the results have been remarkable. During the last six years, in which period the safeguards against loss by fire in all the main works of the mutual companies have been substantially completed, the actual losses have come to about 27 cents per $100 insured for the whole term of six years. Contrasting this figure with the average to the community outside the Mutual risks, which, on the whole, are considered less hazardous, because of the less dangerous occupation of the occupants, the average loss has been from 50 to 60 cents *for each year*—not for the six years. In other words, by developing the study of fire prevention the Mutual companies have reduced their losses to about one-twelfth those where less systematic effort is made to this end.

It would appear, therefore, that there was excellent opportunity for a course in insurance engineering and that graduates from such a course would have a chance to do excellent work for the community as well as for themselves. The Manufacturers' Mutual Insurance Company has organized an insurance experiment station as a preliminary to this course and which, it is expected, will eventually be taken by the Massachusetts Institute of Technology. This station is now issuing bulletins at intervals, sold for a nominal sum, and our article this month upon slow-burning construction for mills and factories is taken from one of these bulletins.

NOTES AND COMMENT.

A feature of the Varied Arts Building of the St. Louis Fair is that ten portrait statues, each 12 feet high, will surmount the columns of the curving colonnade which forms the main entrance on the south facade. The statues will be those of the great inventors who have done most for the development of the various industries by means of their inventions. They are Howe, inventor of the sewing machine; Fulton, the steamboat; Bessemer, steel; Chickering, piano; Clark, telescope; Ericsson, monitor; Watts, steam engine; Colts, firearms; Hoe, modern printing press; Goodyear, rubber.

In discussion before the Institution of Mechanical Engineers Mr. J. H. Wicksteed stated that in English practice it was customary to design machine tools so as to allow 150 feet run of belt for each foot of surface speed of the work. Allowing the maximum pull of a 4-inch belt to be 200 pounds, the theoretical pressure developed on the tool would be 30,000 pounds, which, by frictional resistance, would be reduced to say, 20,000 pounds. In the same discussion Mr. H. F. Donaldson, who read a paper on the cutting angles of tools stated that a friend had designed a boring tool having the cutter ground at such an angle that when it was once started in the work, it would feed itself.

The *Electrical World and Engineer* estimates that the lead cell of an automobile storage battery is capable of lifting its own weight through a height of 5¾ miles in expending its energy without waste. Compared with a piece of good coal, however, it should be remembered that the latter contains enough potential energy to lift its weight 2,000 miles against gravitation so that a lump of coal is 350 times richer in energy than a lump of storage battery. But we can use only five per cent. of the energy of coal in an automobile, whereas we can get 20 per cent. usefully out of a storage cell, at the motor axles; so that the disparity is reduced from 350 to about 20. Even at 20 to 1, the energy storage capacity of coal or petroleum is clearly much greater than that of electric storage cells.

Mr. E. G. Constantine, in an address before the Manchester Association of Engineers has this to say about industries in England and America: Last year I spent a few weeks in the United States, and I am free to confess that I was very considerably impressed by some of the methods in vogue in that country. Any expectations of finding the men working excessively hard were not realized; in such works as I visited—and I spent a good deal of time in some of them—I failed to discover any evidences of exhausting labor, but on the other hand there was an absence of that happy-go-lucky, wandering-about-with-a-piece-of-wood fashion, which we are so painfully conscious exists in some of our works in Britain. Each man appeared to know his job, and to stick at it, and sullen faces were the exception. In the administrative and commercial departments the contrast between American and British practice was startling, and revealed the great factors tending to the success of American enterprises—enthusiasm and loyalty.

In an article on bonding the rails of street car tracks, the *Railway Engineer* refers to some interesting properties of mercury in the following words: "It is a well known fact that mercury will readily unite and form an amalgam with almost every known metal except iron and platinum, and even these can be formed by certain roundabout processes. The mercury will touch an iron surface sufficiently well to admit of electric conduction, but it will not 'wet' it; the molecular attraction between the two is not so great as that between the molecules of mercury themselves; it is insufficient to break down the surface tension of the fluid metal. It is a matter of scientific history that so long ago as 1865 Wurtz and Crookes discovered that the addition of a very small proportion of sodium amalgam to the mercury gave it the power of 'wetting' or amalgamating an iron surface, so that iron plates could be used instead of copper in the extraction of gold from crushed rock."

THE EFFICIENCY OF MECHANISM.*

WITH SPECIAL REFERENCE TO HOISTING MACHINERY.

C. F. BLAKE.

Any combination of fixed and movable pulleys or sheaves whereby power is multiplied, enabling large resistances to be overcome, is called tackle. The most usual form of tackle is that shown in Fig. 6, in which *A* represents the fixed sheaves mounted in some portion of the machine, and *B* represents the movable sheaves in the block to which the load is attached. The sheaves are usually of one diameter, and mounted upon one pin, those in the figure being made of varying diameters to enable the winding of the ropes to be clearly shown. By means of the tables given for the fixed and movable pulleys, we may obtain the efficiency of any arrangement of tackle. Inasmuch as the tackle shown represents a large majority of that in use, it is well to investigate the efficiency of such tackle as a unit.

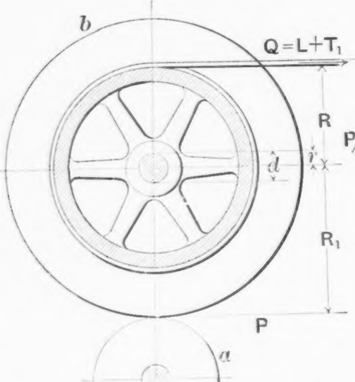


Fig. 4

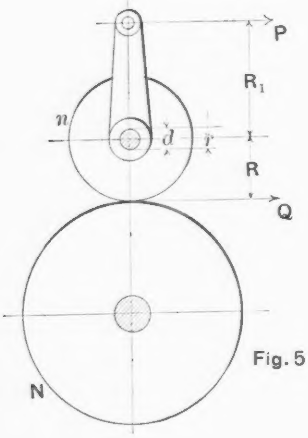


Fig. 5

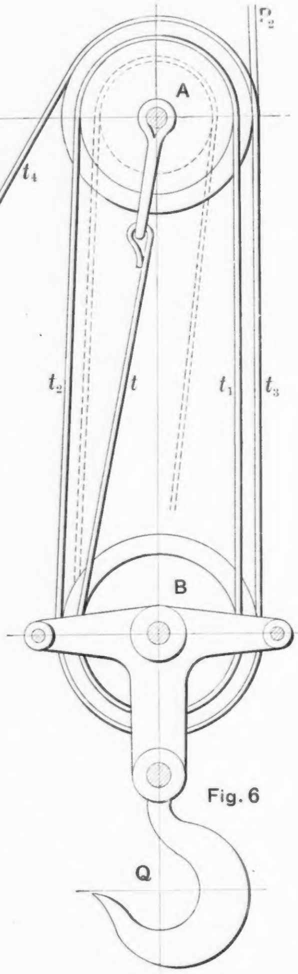


Fig. 6

Industrial Press, N.Y.

The efficiency is in inverse proportion to the number of sheaves in the tackle, which is determined by the number of runs of rope to be used, which in turn is determined (friction being neglected) by the relation

$$\frac{L}{n} = t, \text{ or } n = \frac{L}{t}$$

in which L = the load, n = the number of ropes, t = the tension in each rope, L and t, the known factors determining n.

Thus neglecting friction and all hurtful resistances, we have

$$P_1 = \frac{L}{n}$$

Taking all hurtful resistances into account, it will be seen that the tensions in the several runs of rope are not equal. Thus if t = the tension in the first rope, $t_1 = kt$ = the tension in the second rope, $t_2 = kt_1 = k^2t$ = the tension in the third rope, and $t_{(n-1)} = k^{(n-1)}\,t$ = the tension in the n th. rope. The power end of the rope is not included in the n runs of rope as it has no direct lifting power, the n runs including only those directly connected to the movable block.

In Fig. 6, t_3 = the tension in the last run of rope, and as shown above, $t_4 = kt_3 = k^4\,t$ = the tension in the power end of the rope.

In general, then, for n runs of rope, the tension in the power end $= k^n\,t$, or

$$P = k^n\,t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The hurtful resistances may be considered as added to the load, which then becomes equal to the sum of the tensions in the several ropes connected to the movable block, and we have

$$Q = t + k\,t + k^2\,t + k^3\,t \cdot k^{(n-1)}\,t$$

$$Q = t\,(1 + k + k^2 + k^3 + k^4 \quad k^{(n-1)}) = \frac{t\,(k^n - 1)}{k - 1} \ldots (2)$$

Denoting the distance through which P moves in a unit of time by s, the distance through which Q moves in the same time is $\frac{s}{n}$, and the efficiency of the tackle is

$$e = \frac{\frac{s}{n}\,Q}{P\,s} = \frac{Q}{n\,P}$$

Substituting the values of P and Q from (1) and (2) we have

$$e = \frac{\frac{t(k^n - 1)}{k - 1}}{n\,k^n\,t} = \frac{k^n - 1}{n\,k^n\,(k - 1)}$$

The following table, No. 4, gives the efficiency of tackle under the same conditions as were assumed for single fixed and movable pulleys.

TABLE NO. 4. EFFICIENCY OF TACKLE.

Diam of Rope.	Min. Diam. of Sheave.	Value of k.	Efficiency $= e = \frac{k^n - 1}{n\,k^n\,(k-1)}$ Number of Runs of Rope 2	3	4	5	6	Average.
½	10	1.081	.888	.856	.823	.793	.767	.825
⅝	12	1 068	.909	.879	.853	.826	.800	.853
¾	14	1.058	.915	.893	.869	.843	.823	.868
⅞	16	1.050	.927	.907	.880	.861	.845	.884
1	18	1.045	.935	.915	.897	.875	.860	.896
1⅛	20	1.040	.941	.925	.898	.880	.871	.903
1¼	22	1.036	.948	.933	.909	.897	.883	.912
	Average		.923	.915	.875	853	.835	

Winding Drums.

Let Fig. 4 represent a winding drum operated by two gears, of which the pitch lines are a and b, by means of which a load L is to be moved by the application of a force P at the pitch line of the larger gear b. The distances through which P and L move are proportional to the radii of the gear and drum, so that

$$P_1\,R_1 = L\,R \text{ and } P_1 = \frac{L\,R}{R_1} \ldots\ldots\ldots (1)$$

The wasteful resistances to be overcome are: 1st. The stiffness of the rope requiring an additional force T_1, which may be added to the load L, making the total force acting in the rope

$$Q = L + T_1, \text{ and}$$

2nd. The journal friction due to the resultant pressure of P and Q, and to the weight W of the drum when wound full of rope or chain.

The stiffness of the rope may be neglected at first to be brought into the solution later, which makes $Q = L$, and assuming P and Q to be parallel, the maximum value of their resultant is $P + Q = 2L$, when the condition of equilibrium, (ϕ being the coefficient of journal friction) becomes

$$P\,R_1 = L\,R + 2\,L\,r\,\phi + W\,r\,\phi = L\,R + r\,\phi\,(2\,L + W)$$

$$P = \frac{L\,R + r\,\phi\,(2\,L + W)}{R_1} \ldots\ldots\ldots (2)$$

Letting the efficiency of the rope $= e_2$, and neglecting the

* This is the second installment of Mr. Blake's contribution on the subject, and completes the article. The first installment appeared in the March number.

weight W of the drum and rope, we get from (1) and (2) the efficiency

$$e = \frac{P_1}{P} e_2 = \frac{\dfrac{L\,R}{R_1}}{\dfrac{L\,R + 2\,r\,\phi\,L}{R_1}} e_2$$

$$e = \frac{e_2\,R}{R + 2\,r\,\phi} = \frac{e_2\,R}{R + d\,\phi}$$

where d equals the diameter of drum shaft.

Table No. 5 gives the efficiency of drums for various sizes of ropes strained to their full capacity, the drum shafts being of such assumed diameter as to cover extreme practice, and the coefficient of journal friction being taken as .08.

TABLE NO. 5. EFFICIENCY OF WINDING DRUMS.

Diam. of Rope.	Min. Diam of Drum.	Value of e_2.	Assumed Diam. of Shaft.	$e = \dfrac{e_2\,R}{R + d\,\phi}$	Coef of Resistance $k = \dfrac{1}{e}$
½	10	.982	3	.939	1.064
⅝	12	.985	3½	.943	1.060
¾	14	.987	4	.945	1.058
⅞	16	.989	4½	.967	1.034
1	18	.990	5	.950	1.053
1⅛	20	.991	5½	.951	1.051
1¼	22	.992	6	.953	1.049
			Average,	.949	1.053

In the case of heavy drums wound with large wire rope or heavy chain, it is sometimes desirable to take into account the weight W, in which case the formula should be used.

$$P = \frac{Q\left[R\left(1 + \dfrac{1}{3\,n} + \dfrac{1}{3\,N}\right) + 2\,\phi\,r\right]}{R_1} \quad \ldots\ldots (2)$$

The efficiency of the gear and shaft is

$$e = \frac{P_1}{P} = \frac{\dfrac{Q\,R}{R_1}}{\dfrac{Q\left[R\left(1 + \dfrac{1}{3\,n} + \dfrac{1}{3\,N}\right) + 2\,\phi\,r\right]}{R_1}}$$

$$= \frac{R}{R\left(1 + \dfrac{1}{3\,n} + \dfrac{1}{3\,N}\right) + \phi\,d}$$

where d = the diameter of shaft.

As the expression $\left(1 + \dfrac{1}{3\,n} + \dfrac{1}{3\,N}\right)$ increases in value as the number of teeth diminishes, it follows that the number of teeth in the large gear remaining constant, the efficiency of the pinion and shaft is greater as the number of teeth n is greater. A smaller pinion than one of thirteen teeth being little used, $n = 13$ has been taken as the basis of the following table, No. 6. The pitch of the pinion being taken as 1¾ inches, gives the pitch diameter for a pinion of thirteen teeth as 7¼ inches nearly. The diameter of the pinion shaft is taken as 3 inches, and the table gives the efficiency of the pinion and shaft when running in mesh with gears of various numbers of teeth, giving various velocity ratios.

TABLE NO. 6. EFFICIENCY OF GEARS AND SHAFTS,

No. of Teeth in Pinion.	Pitch in inches.	Pitch Diam. of Pinion Approx.	Diam. of Pinion Shaft.	$e = \dfrac{R}{R\left(1+\dfrac{1}{3\,n}+\dfrac{1}{3\,N}\right) + d\,\phi}$ Number of Teeth in Gear and Velocity Ratio.														
				T	R	T	R	T	R	T	R	T	R	T	R	T	R	
13	1¾	7¼	3	13	1:1	20	1:1½	26	1:2	39	1:3	65	1:5	91	1:7	117	1:9	Average
				.922		.929		.933		.937		.940		.941		.942		.934
Coef. resistance $k = \dfrac{1}{e} =$				1.084		1.076		1.072		1.067		1.064		1.062		1.061		1.070

Gearing.

In Fig. 5, let P = the power applied at a radius R_1, to drive a gear of pitch radius R, having n teeth, and meshing with a gear having N teeth, at the pitch line of which there is a resistance to rotation, $= Q$. Neglecting all wasteful resistances, we have the theoretical force

$$P_1 = \frac{Q\,R}{R_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The wasteful resistances to be overcome are the friction between the teeth of the two gears, and the friction of the journal A.

The friction between the teeth is given by Weisbach as

$$Z = \pi\,\phi\,Q\left(\frac{1}{n} + \frac{1}{N}\right)$$

which, assuming the direction of Q to be normal to the common center line of the two gears, becomes

$$Z = \frac{Q}{3}\left(\frac{1}{n} + \frac{1}{N}\right) = \frac{Q}{3\,n} + \frac{Q}{3\,N}$$

which acts through a lever arm R.

In most cases occurring in practice, the forces P and Q are either arranged on opposite sides of a journal bearing, or one force at each end of a shaft next to a journal bearing. It is thus a close approximation to actual conditions to take the weight upon the journals as $W = 2Q$. Then taking into consideration the wasteful resistances, we have the condition of equilibrium,

$$P\,R_1 = Q\,R + \left(\frac{Q}{3\,n} + \frac{Q}{3\,N}\right)R + 2\,Q\,\phi\,r$$

Efficiency of a Complete Machine.

From the consideration of the efficiency of the several mechanisms which, combined, form a machine, we may by the general formula already given,

$$e = e_1 \times e_2 \times e_3 \times e_4 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots e_n$$

pass to the determination of the efficiency of the complete machine.

Fig. 7 represents the several elementary parts of a crane. The power is applied at the crank F upon the crankshaft A, and a pinion a upon this shaft meshes into a gear b upon the intermediate shaft B. A pinion b_1 upon this shaft meshes with a gear c upon the drum shaft C. Thus the power is transmitted to the drum E upon which the rope which passes to the tackle D is wound, and thus the load Q is raised. The speed reduction of the two gears is shown in the figure as 1 : 4 in each case, and the tackle is shown as having four runs of rope. This completes the elementary crane. There are many devices such as friction pawls, ratchet wheels, band brakes, etc., which are applied to cranes for various purposes, but these do not as a rule affect the efficiency of the machine.

In the following consideration of the efficiency of the complete machine the average values given in the preceding tables will be used as follows:

e_1 = the efficiency of pinion a and shaft A (table No. 6) = .934
e_2 = the efficiency of pinion b and shaft B (table No. 6) = .934
e_3 = the efficiency of drum E and shaft C (table No. 5) = .949
e_4 = the efficiency of tackle D, 4 ropes (table No. 4) = .875.
e = the efficiency of the complete machine $= e_1 \times e_2 \times e_3 \times e_4$
then $e = .934 \times .934 \times .949 \times .875 = .723$.

While on account of the small force available for operation, the hand crane is usually double geared, the steam crane,

being operated by much greater force, is often single-geared. Thus, should a steam crane be applied to the elementary crane of Fig. 7, the shaft *A*, pinion *a*, and gear *b* would be omitted, and shaft *B* would become the engine shaft. The mechanical efficiency of small, simple slide valve engines is given by several authorities as 85 per cent. to 90 per cent. Assuming the smaller of these two values, we have

$e_1 =$ the efficiency of the engine................ .850
$e_2 =$ the efficiency of the pinion and gear........ .934
$e_3 =$ the efficiency of the drum and shaft........ .949
$e_4 =$ the efficiency of the tackle................ .875
$e = .850 \times .934 \times .949 \times .875 = .656.$

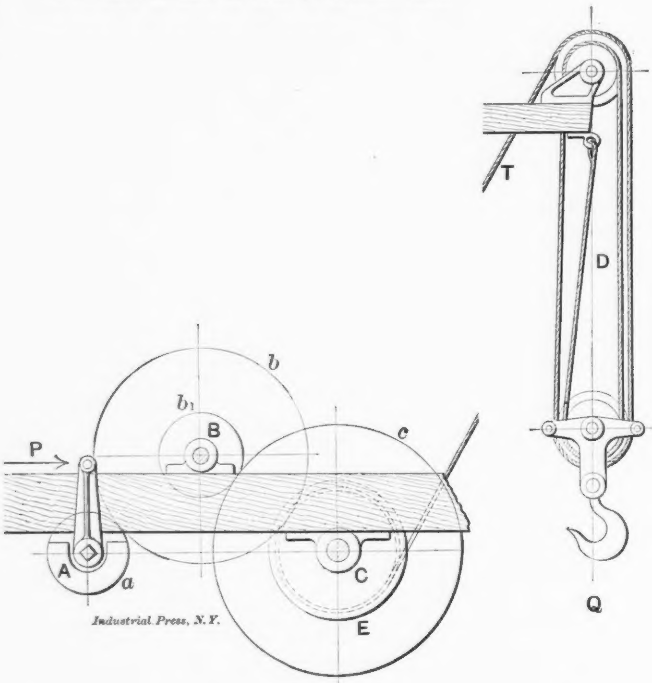


Fig. 7.

Taking the above value obtained for the hand crane as a basis, we have the coefficient of resistance for the complete crane, $k = \frac{1}{e} = \frac{1}{.72} = 1.38$ Example: One man can exert a force of about 30 pounds upon a crank handle. If four men are working at a crank *F*, 16 inches long, the ratio of the gears *a*—*b* and *b*—*c* is 1 to 4 in each case, and the diameter of the drum is 24 inches; the force or pull in the rope wound around the drum is

$$T = \frac{120 \times 16 \times 4 \times 4}{12} = 2560 \text{ pounds.}$$

Fig. 7 shows the crane as having four runs of rope, which gives the load

$$Q = 2{,}560 \times 4 = 10{,}240 \text{ pounds.}$$

The actual load *L* that can be raised by four men working this crane would be, assuming the efficiency as 72 per cent.,

$$L = 10{,}240 \times .72 = 7{,}372 \text{ pounds, or about } 3\tfrac{1}{2} \text{ tons.}$$

Conversely: A load of 3½ tons is to be raised by such a crane. We have the force or pull in the rope

$$T = \frac{7000}{4} = 1750 \text{ pounds.}$$

Then the power required at *P* is

$$P = \frac{1750 \times 12}{4 \times 4 \times 16} = 82 \text{ pounds nearly.}$$

The coefficient of resistance is 1.38, and we have the actual force required on the crank *F* as

$$P = 82 \times 1.38 = 113 \text{ pounds nearly,}$$

which would be fair work for four men.

* * *

High temperatures are now easily measured with the electric incandescent lamp. The lamp, in line with the furnace, backing or other hot object, is viewed through a small telescope, when the filament disappears on reaching the temperature of the background. An ammeter shows the amount of current feeding the lamp, while a special scale indicates very accurately temperatures up to 3,600 degrees Fahr.

STEEL VS. CONCRETE FOR FLOORS.

In a contribution to *Insurance Engineering*, Frank B. Abbott contends that the steel floor beams used universally in the modern steel buildings are a useless and extravagant appendage. Fire and corrosion are the enemies of steel, and it follows that, when the requirements of strength and durability have been met the less steel there is in a building the less danger there will be from these enemies, and the safer the building. Also, the less steel required in a building, the more nearly fireproof the building will be, provided a better substitute can be found. He holds that long floor arches between the steel floor girders cost less per square foot than the short arches usually built between the steel floor beams spaced near together, and supported by the girders. The floor beams constitute about one-half the total steel tonnage of the average fireproof building; and yet they have been a necessary part of the framework, for arches of concrete and brick, having greater spans than the length of the average floor beam, and carrying greater loads, have been in use a thousand years. The average fireproof building, taking this country at large, contains more than 1,500 tons of structural steel, but, assuming a basis of 1,500 tons, the cost, at $60 per ton erected in the building (the present cost is about $70) is $90,000, and as about one-half of this tonnage is in the floor beams, there has been expended, therefore, not less than $45,000 uselessly—$45,000 paid out in the construction of the building without adding one dollar to its value, or strength, or earning power. In a thousand such buildings, and there are many more than this in the United States, we have the enormous sum of forty-five million dollars thrown away, except as it has helped to swell the profits of the "steel trust," and when we eliminate one-half the structural steel from a building we eliminate one-half of the risk from fire and corrosion—an important matter, viewed from an insurance standpoint. How much further we may go in this process of elimination remains to be seen. There is less need, however, for further elimination, because the steel column and the girder perform necessary structural functions, while the beams have always been superfluous.

Having dispensed with the beams, it is best that we determine at once, before paying any more premiums to ignorance or cupidity, what are the best materials and methods of construction for the floor arches which replace them. The requirements of these arches are that they shall be fire-resisting, have the requisite strength, and be of such nature and construction as to prevent the corrosion of the steel girders. As to the first two requirements, bricks, terra-cotta or concrete will answer equally well; as to the third requirement, only one, i. e., concrete, will do the work. If the girders are well grouted with cement or lime grout, however, the other materials will answer; but in practice that material which requires the least outlay in time and money, after meeting the above requirements, will be the one used.

Cement affords absolute protection against corrosion to steel work, when properly applied. Structural steel need not be pickled, or put under a sand blast, or treated in any other expensive manner, nor should it be painted, before being concreted in. It is only necessary that it be thoroughly brushed with wire brushes, so as to remove all dirt and loose scales, for cement has a strong affinity for steel and iron. Any incipient corrosion that may be set up during the construction of the building will be so slight that it may be disregarded, and as soon as the concrete sets corrosion is arrested, and after the concrete hardens it can be removed only by the use of cold chisel and hammer.

As to the strength of concrete the writer recently witnessed a test of a concrete arch 5½ feet wide and 16 feet span made as follows: Natural cement one part, lake sand one part, cinders four parts, and in the concrete were imbedded three 2-inch by 2-inch steel T-bars, curved to the radius of the arch, and supported by the lower flanges of the girders. The arch was 20 inches deep at girders and 8 inches at crown, and had a rise, therefore, of 12 inches. After standing 30 days the arch was loaded to the extent of 900 pounds per square foot, and sustained this load for 30 days without visible deflection.

SLOW-BURNING CONSTRUCTION.

FOR SHOPS AND MANUFACTURING BUILDINGS.

In one of the recent reports of the Insurance Experiment Station, Boston, Mass., are several studies of what is known as the "Slow Burning" or "Mill" type of construction of buildings, which has proven so satisfactory for textile mills and many other branches of manufacturing, including machine work. There is no type of building which is on the whole better adapted for machine shops of medium size, especially when the building is to have several floors, than this type, in which wooden columns and floor beams are employed instead of the usual steel columns and beams generally found in modern shop buildings.

It may be said that the theory of the slow-burning or mill type of construction is that heavy timbers and solid plank flooring will withstand the ravages of fire for hours, where floors supported by steel columns and beams might sag or even fall, through the bending of the steel members, due to the intense heat of the flame. Mill buildings generally have brick walls, supporting massive floor timbers, widely spaced, with thick plank floors, tongued and grooved, covered with a layer of hard wood flooring; and large square wooden columns. If there are no openings in such floors, for belts, stairs, elevators, pipes, etc., by which fire can get a foot-hold, they will effectually prevent the spread of flame either up or down, and will confine the fire between floors for hours without burning through. The large timbers, also, when once charred, do not seem to burn to any great extent, even under the most severe conditions, and will remain intact longer than even granite columns under intense heat.

The following concise statement of what Mill Construction is and what it is not, as well as the practical information relating to the design of such buildings is taken from the pamphlet referred to containing the report of the Insurance Experiment Station and will form a valuable supplement to the articles on shop construction now running.

What Mill Construction Is.

1. Mill construction consists in so disposing the timber and plank in heavy solid masses as to expose the least number of corners or ignitable projections to fire, to the end also that when fire occurs it may be most readily reached by water from sprinklers or hose.

2. It consists in separating every floor from every other floor by incombustible stops—by automatic hatchways, by incasing stairways either in brick or other incombustible partitions—so that a fire shall be retarded in passing from floor to floor to the utmost that is consistent with the use of wood or any material in construction that is not absolutely fireproof.

3. It consists in guarding the ceilings over all specially hazardous stock or processes with fire-retardant material such as plastering laid on wire-lath or expanded metal or upon wooden dovetailed-lath, following the lines of the ceiling and of the timbers without any interspaces between the plastering and the wood; or else in protecting ceilings over hazardous places with asbestos air cell board, sheet metal, sackett wall board or other fire-retardant.

4. It consists not only in so constructing the mill, workshop or warehouse that fire shall pass as slowly as possible from one part of the building to another, but also in providing all suitable safeguards against fire.

What Mill Construction is Not.

1. Mill construction does *not* consist in disposing a given quantity of materials so that the whole interior of a building becomes a series of wooden cells; being pervaded with concealed spaces, either directly connected each with the other or by cracks through which fire may freely pass where it cannot be reached by water.

2. It does *not* consist in an open-timber construction of floors and roof resembling mill construction, but of light and insufficient size in timbers and thin planks, without fire-stops or fire-guards from floor to floor.

3. It does *not* consist in connecting floor with floor by combustible wooden stairways incased in wood less than two inches thick.

4. It does *not* consist in putting in very numerous divisions or partitions of light wood.

5. It does *not* consist in sheathing brick walls with wood, especially when the wood is set off from the wall by furring, even if there are stops behind the furring.

6. It does *not* consist in permitting the use of varnish upon woodwork over which a fire will pass rapidly.

7. It does *not* consist in leaving windows exposed to adjacent buildings unguarded by fire shutters or wired glass.

8. It is dangerous to paint, varnish, fill or incase heavy timbers and thick plank as they are customarily delivered, lest what is called dry-rot should be caused for lack of ventilation or opportunity to season.

9. It does *not* consist in leaving even the best constructed building in which dangerous occupations are followed without automatic sprinklers, and without a complete and adequate equipment of pumps, pipes, and hydrants.

10. It does *not* consist in using any more wood in finishing the building after the floors and roof are laid than is absolutely necessary, there being now many safe methods available at low cost for finishing walls and constructing partitions with slow-burning or incombustible material.

It follows that if plastering is to be put upon a ceiling following the line of the under side of the floor and the timber, it should be plain lime mortar plastering, which is sufficiently porous to permit seasoning. Adding a skim coat of lime putty is hazardous, especially if the top floor is laid upon resin-sized or asphalt paper. This rule applies to almost all timber as now delivered.

Standard Type for Building.

The illustration on page 414 shows the section of a mill of the customary or standard type. Two floors are pictured, showing a section of the wall, cut off at pilasters between the windows, the thickness of panels to be adjusted to the thickness designated in the drawing. If additional stories are required, the walls may be increased in thickness according to the number of stories added, after a computation of the loads which a standard factory may be called upon to sustain.

The window at the left represents what is known as the English type of window—the lower sash being either fixed or swinging on hinges, the upper sash mounted like a transom, and opening inward for ventilation. Attention is called to the fine ribbed glass which is translucent but not transparent, diffusing the light, making no hard shadows, and preventing the glare of sunlight to such an extent that window shades are seldom required.

It is assumed that no well-informed mill owner, engineer or builder would fail to construct the stairways in towers or sections of the building, cut off by incombustible walls from all the rooms of the factory, the entrances to each room being guarded with standard fire-doors. In modern practice, all belts or ropes which may be used for the transmission of power to the various rooms, are placed in incombustible, vertical belt chambers from which the power is transmitted by shafts through the walls into the several rooms of the factory. There should be no unprotected or unguarded openings in the inner walls of this belt chamber.

Elevator shafts and belt towers or chambers should be guarded by fire-doors and covered overhead by skylights, glazed with thin glass, protected underneath with wire netting. Hatchways outside of fire-proof shafts should be well guarded by automatic or self-closing hatches, both to stop the passage of fire and to assure safety to persons. The most important feature in what is called slow-burning construction is to make each and every floor continuous, avoiding belt holes and open ways to the utmost possible extent, so that a fire originating in any one room may be confined to that room or story, if possible.

Timbers, unless known to be absolutely and fully seasoned, should not be incased in any kind of air-proof plastering, nor should they be painted with oil paints—whitewash, kalsomine and water paints may be used, as they are porous. Timbers or plank may also be covered in with common lime mortar laid on wire lathing, provided no skim coat of lime putty is added. Ordinary plastering unskimmed is sufficiently porous to permit seasoning. As a rule, timbers may be left unpro-

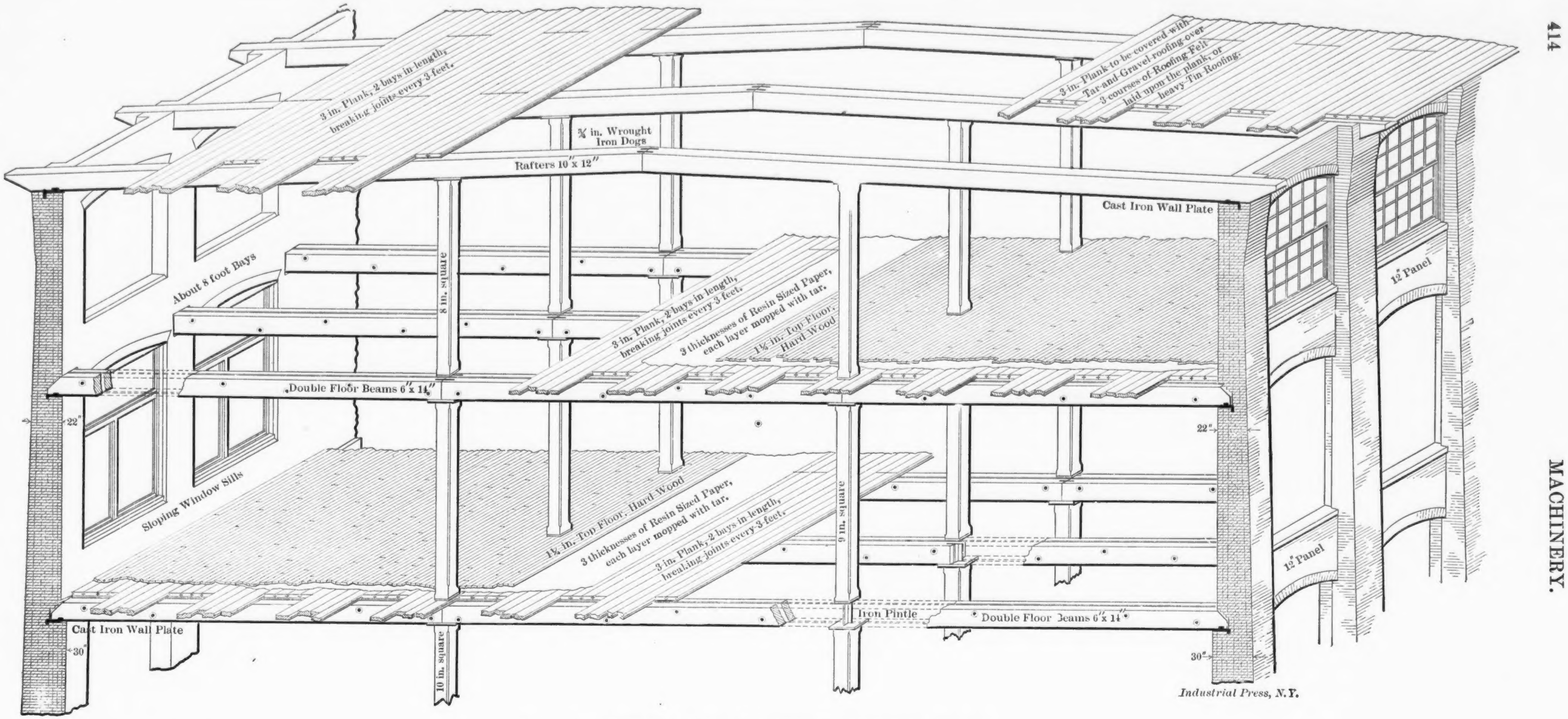


Fig. 1. Slow-burning or Mill Type of Building for Manufacturing Purposes.

tected, except in very dangerous places, since any fire which will seriously impair and destroy a heavy timber will already have done its work upon other parts of the structure.

In many instances it may be preferable to substitute compound beams for single timbers, made by securing two or more beams or thick planks side by side, it being often easier to obtain well seasoned lumber in smaller dimensions; such compound beams, of which the parts may be slightly separated by spaces for ventilation when put together, are less subject to decay.

Buildings in which there is excessive vibration through the motion of machinery can be made more rigid and more capable of resisting the vibration by laying the top floor across the plank and parallel to the beams, nails being driven in diagonal rows. This may brace the floor as firmly as diagonal boarding, and it avoids the increased expense in construction and repairs which ensues from the adoption of that method.

The edges of the floor plank should be kept clear of the faces of the brick walls by about half an inch, in order to obviate the danger of cracking the walls, which sometimes occurs from the swelling of the plank when laid close against them. These cracks must be covered by strips or battens both above and below.

To protect the contents of floors below, three thicknesses of tarred paper should be placed between the floor plank and top floor, each layer to be mopped with tar, asphalt or similar material, care being taken to break all joints.

Basement floors can be laid solid upon the natural soil if it is dry, or upon rock or cinder filling, by covering either with a suitable layer of coal-tar concrete. Upon this concrete place an under floor of two-inch seasoned plank. Then lay the top flooring across the plank and nail in the usual manner. Sills under the plank are not thought to be necessary to the preservation of the floor. If extra support is required to sustain machinery more firmly than it can be upon a plank and board floor, independent foundations of masonry are generally preferred. Cement concretes may absorb moisture and promote the decay of timber or plank laid upon them.

In view of the difficulties which have frequently occurred in preserving basement floors of the ordinary timber construction, for lack of suitable ventilation underneath, and also in view of the rapid decay of timber and plank floors in bleach-

eries, dye works, print works and the like, where they quickly become saturated with moisture, artificial stone floors are being laid in many of the modern plants.

If the building is to be heated by conveying steam through pipes, such pipes should be hung overhead. If the modern method, which is probably the best method, of conveying the heat through ducts in the plastered walls should be adopted, provision will be made thereto in the construction of the mill wall.

The carrying off from the walls of about one-half a roof corresponding to this plan, in a hurricane, is an instance which calls attention to the necessity of tying, binding or bolting the timbers of the roof to the walls of the mill in a safe and suitable manner. This is the common practice, but the necessity is sometimes overlooked.

Single Story Machine Shop.

For workshops on cheap, level land, especially where the stock is heavy, one-story buildings have proved to be more economical in cost of floor area, supervision, moving stock in process of manufacture, and repairs to machinery—many kinds of which can be run at greater speeds than when in high buildings.

Such buildings are readily warmed and ventilated, and heavy plank roofs are free from condensation in cold weather; the large window area reduces the hours of artificial illumination. Forced circulation of heated air is a very desirable method of heating a mill, being economical as to maintenance and repairs, and thoroughly under control. Overhead steam pipes are very satisfactory, if used in the ratio of one foot of $1\frac{1}{4}$-inch pipe to 70 cubic feet of air.

Floors over an air space or on cement are subject to dry-rot. Asphalt or coal-tar concrete is softened by oil, and the dust will wear machinery, unless covered by flooring. Floors made by laying sleepers on six inches of pebbles, tarred when hot, then two inches tarred sand flush to top of sleepers and covered by double flooring, have remained sound since 1865; but double flooring at right angles can be laid on the concrete without the use of sleepers, and nailed together. It is usually preferable to secure nailing strips to stakes four feet apart each way and driven to grade, concrete flush to top of strips, and lay single $1\frac{1}{2}$-inch flooring.

Piers reach to roof timbers, and light walls to window sills are finished with slope on inside. To increase the window area over that shown in the elevation, the brick piers between the windows may be narrowed and made thicker so as to give the requisite strength, leaving more space for light. Large windows are placed high, and the sashes separated by a mullion. Lower sashes should be stationary and glazed with ribbed glass, with transom sash or window ventilators above. If the light is too strong, apply to glass white zinc and turpentine. Monitors may well be glazed with ribbed glass.

Wooden mill columns, Southern pine or oak, safely sustain loads of 600 pounds per square inch; a square column is stronger than a round one of the same diameter. They should have a $1\frac{1}{2}$-inch core bored from end to end, and two half-inch holes through the column near to each end. The columns should be securely held at each end, the base resting on iron plates projecting above the floor level, and the caps at the top bolted to the roof beams.

Double or solid timbers of Southern pine support the roof plank, and the ends pass through the wall, and are finished as brackets to the cornice: or another plan often adopted is to make a projecting brick cornice covering the ends of the roof timbers, thus avoiding the exposure to an outside fire. The beams are anchored to plates in the walls by means of tongues which project into grooves across the lower side of the beams. Beams should not be painted or varnished until thoroughly seasoned.

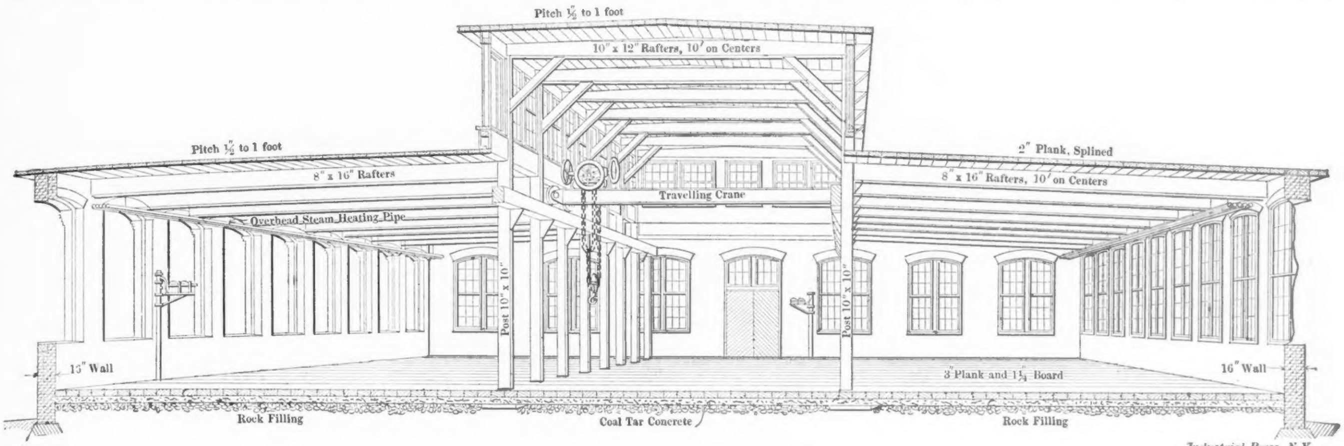


Fig. 2. Single Story Machine Shop.

The roof plank should be two bays in length, breaking joints every three feet. There is no need of gutters, but a concrete walk at the ground level, sloping toward drains, will take the water from the roof. Do not drive nails upward into the roof plank, as moisture will condense and drop from the heads.

Monitors must be of solid construction.

The roof should be tied by binding or bolting the timbers of the roof to the walls of the mill in a safe and suitable manner. This is the common practice, but the necessity is sometimes overlooked. The saw-tooth roof is taking the place of the monitor roof in many buildings, and it requires, in each case, the service of a competent engineer and constructor to plan the roof so as to meet special conditions, and to supervise the work.

Fig. 3. Exterior of Single Story Structure.

* * *

The lightest known wood is said to be the so-called cork-wood tree, which in the swamps of Southeastern Missouri reaches a height of 15 or 20 feet and a diameter of two to five inches, and is found in occasional small species in Florida and Arkansas. Its specific gravity is .207, while that of its roots is only .151. The wood, though spongy, is far tougher than cork. The specific gravity of cork—which is the outer bark of a kind of oak—is .240, while that of most woods is between. .400 and .800, and that of the heaviest woods is greater than of water, that of American ebony, for example, being 1.331.

* * *

In England, the Sunderland Town Council has decided to try the experiment of supplying electricity for the lighting of the workmen's dwellings owned by the municipality on the penny-in-the-slot principle. The corporation propose to supply an 8-candle power light which will last five and one-fifth hours for one penny.

ENGINEERING REVIEW.

CURRENT EVENTS, TECHNICAL AND MECHANICAL—LEADING ARTICLES OF THE MONTH.

The report of the Commissioner of Patents for the calendar year 1902 shows a total of 49,490 applications for patents, including designs, and that 27,776 patents, including designs, were issued. In addition there were 110 patents reissued, 2,006 trade marks registered, and 767 labels and 158 prints registered. During the year, 23,331 patents expired, 4,471 applications allowed were forfeited because of non-payment of fees, and 9,284 allowed applications are still awaiting final fees. The excess of receipts over expenditures was $159,514.

The American Foundrymen's Association has recently organized a "Metallurgical Section." This was undertaken in response to an increasing demand for an organization to harmonize methods of analysis of iron. It is designed to increase the use of metallurgy in foundry and furnace work, and to serve as a board of exchange, as it were, for those interested in the study of iron as a specialty. All furnaces, foundries, individual chemists and independent laboratories who would be interested to receive more particulars concerning this Section are requested to send their names to the Secretary, Herbert E. Field, at Box 104, Ansonia, Conn.

Plans for the fourth bridge across East River, New York, have been completed and accepted by the city engineers. The design is for a suspension bridge, involving several novel ideas for a structure of this magnitude. The central span will be 1,475 feet, with two side spans, each 725 feet long. Total width 96 feet. In place of cables immense eye-bar chains are to be employed. If possible these will be of special steel having an elastic limit of 50,000 pounds per square inch. The cross-sectional area of these chains will have to be about double the area of cables to sustain the same load, including their own weight, but they will have the advantage of accessibility for examination and repair, while the inner strands of a cable are of course entirely closed from view. The bridge towers embrace the most novel feature of the structure. Each tower is really a bent and consists of four vertical posts, made up of structural steel. Each is supported on a pin at the bottom and the chains are rigidly connected to pins at the top, instead of passing over shoes in the usual manner. There will thus be no slipping or rubbing due to expansion and contraction of the cables, as this is to be compensated for entirely by the swinging of the towers.

One of the last bills to be passed and become a law during the last session of Congress was one relating to patents and trademarks. The bill was for the purpose of completing the compact between the United States and the more important foreign nations with regard to international protection of industrial property, according to terms of an agreement entered into at a convention in Belgium over two years ago. Without the passage of this act the United States could not have enjoyed the privilege of the other terms of the treaty and hence the bill is of greater importance than the mere text of its provisions would indicate. The general result of the bill, as explained by the *Scientific American*, will be not only to extend the time in which foreigners may file their applications in the United States patent office, but also provides that when an application is filed in the United States by any person who has previously filed an application for a patent in a foreign country which by treaty, convention, or law, affords similar privileges to citizens of the United States, the application in the United States shall have the same force and effect as though it were filed in this country on the date on which the application for a patent for the same invention was first filed in such foreign country. The effect of this amendment will be far-reaching, as for instance in interference cases, where the foreign inventor may claim the date of the filing of his first foreign application, for all purposes, as his date of filing in the United States patent office, although the actual filing of the application papers in the United States patent office was not made until nearly a year after such date. Under the amendment, foreign inventors will be obliged to file their applications for design patents within four months of the filing of their first foreign application.

The plan and scope of the Carnegie Institution at Washington, D. C., endowed by Andrew Carnegie, for scientific investigation and research, was outlined in the February issue of *Science*. The work of this institution is to be conducted by the distribution of funds for the assistance of individuals, and in some cases of societies or institutions qualified by training or equipment to carry on investigations, and it is proposed to make grants of money for this purpose, mainly; though a certain amount will be available for the purchase of apparatus, instruments, books, etc., to aid persons of marked ability in original work, such apparatus or materials remaining the property of the Carnegie Institution. It is not proposed to equip the institution with buildings for research such as is done in the engineering laboratories of our technical schools or to attempt courses of instruction or to otherwise conflict with organizations already doing good work in the field of engineering or science. Although efforts will be made to cooperate with all such agencies established for the advancement of knowledge, care will be taken to avoid interference or rivalry. For example, if medical research is provided for by other agencies, as it appears to be, the Carnegie Institution will not enter that field. Sites or buildings for other institutions will not be provided nor will assistance be rendered to students in the early stages of their studies. All work for which grants are made will be subject to the approval, or be placed under the direction of the committee in charge and in this way it is hoped to avoid duplication in tests or investigation; and a thorough plan of procedure will be mapped out to insure systematic work. For the present year $200,000 are at the disposal of the committees for rendering assistance in the various fields to be covered, and $40,000 to cover the expenses of publishing the results.

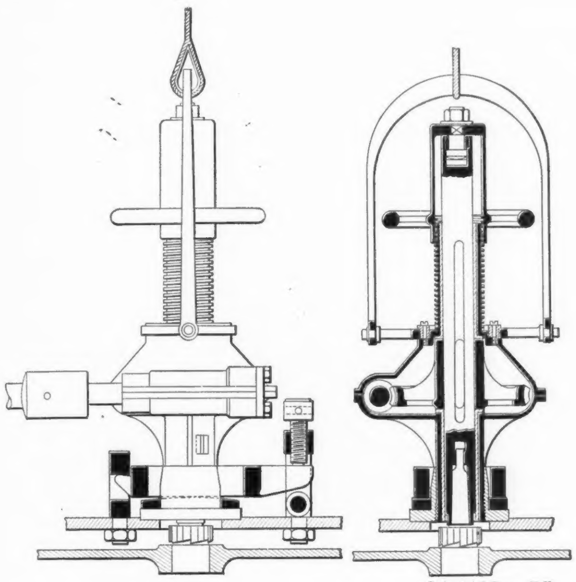
On March 3 the Brush patent on storage battery electrodes expired. This is one of the most remarkable patents in the field of electrical engineering and its termination will enable new manufacturers of storage batteries to come into the field, and many of the present manufacturers to improve their product. The patent has formed the basis of extended litigation, but its claims were broad enough to stand. In commenting upon this patent the *Electrical World* publishes the following interesting paragraph:

It is now almost twenty-two years since Sir William Thompson sensationally introduced the storage battery to the world by remarking dramatically at a scientific gathering that a small box he held in his hand contained one million foot-pounds of stored energy. The statement caught the fancy of the newspapers of the world, and for a long period the storage battery monopolized attention to the exclusion of other current electrical developments. Highly capitalized companies were everywhere formed to exploit the new marvel, inventors the world over turned attention to its improvement, and patent offices were overwhelmed with applications based upon their work. Four years later the electrical public was startled by the issue of a patent to Charles F. Brush, which not only covered the whole previous art, excluding Planté cells, but also any improvements to the composite plate that might be made during its life of seventeen years—which only ended last week. Though the very principle of the storage battery as developed from the beginning of last century involved a metallic structure, the Brush patent of March 3, 1886, covered absolutely the use of a metallic support in connection with any improvement offered, which claim practically closed the art to all except the owners of the patent, and rendered subsidiary to it the many hundreds of patents which irrepressible inventors nevertheless insisted upon taking out during its life.

PORTABLE UNIVERSAL MACHINE TOOL.

Le Genie Civil.

It is generally acknowledged to be frequently of a very great advantage in the execution of heavy work to be able to take the tool to the work rather than the work to the tool. Many devices have been brought out for that purpose, and among them is the one shown in the accompanying illustration and designed by Emile Capitaine & Co., Frankfort-on-Main, Germany. The apparatus, as shown in Figs. 1 and 2, consists of a hollow spindle carrying the tool, which is rotated by a small electric motor, acting through a flexible shaft and a worm gearing, the latter being integral with the machine. The longitudinal movement of the spindle is effected by means of a nut turned by a hand wheel, and which engages in a thread cut upon the tube holding the spindle in line. The whole is fitted with a stirrup so connected that it can be suspended and balanced in any position best adapted for the execution of the work in hand.



Industrial Press, N.Y.

Fig. 1. Fig. 2.

In the application of this device there are a number of combinations of supports that have been designed by which it has been possible to so hold the machine that it can execute even complicated work with a great degree of precision and that, too, without being obliged to change the position of the parts during the operation. It can be used for boring, drilling, reaming, facing off cylinders, cutting out ports and other work of a similar character. In adjustment it is only necessary to hold the frame rigidly in position, which can be done by bolting or clamping, as shown in Fig. 1, and the tube then holds the spindle in line.—G. L. F.

REAL PROFIT-SHARING AND ITS RESULTS.

The Independent, March 12, 1903, p. 619.

The Rev. George L. McNutt, who has spent the past four years as a working man, investigating the conditions of the laborer from his own standpoint, gives an account of the profit sharing plan that is in operation at the pump and windmill manufactory of A. S. Baker & Co., at Evansville, Wisconsin. This company was founded in 1873, but owing to divided management was operated unsuccessfully for a number of years. It was then placed under the absolute management of Mr. Baker, and in 1891 the first dividend was declared. In 1897 Mr. Baker's son, J. S. Baker, was made a director of the company. He had been a student at the University of Wisconsin, and was imbued with the justice and necessity of democratizing industry. After two years of careful study he devised a plan for profit sharing, which was adopted by the company in February, 1899.

As a beginning, each man who had been in the company's employ during the past year was given a bonus of 10 per cent. on his wages. Meanwhile the business of the company was enlarged by increasing the capital stock to $300,000; $200,000 of this was preferred stock, fully paid up, and $100,000 to be issued in profit sharing between labor and capital in proportion to the earnings of each, the earnings of capital being arbitrarily fixed at 5 per cent. on preferred stock, and the earnings of labor being the amount earned by each employee on day wages or salaries during each year.

Just here is the genius and value of the plan as devised and carried through by the Baker Company. Instead of treating, as is usual, a dollar of preferred stock and a dollar of wages as of equal standing in the division of profits, so that if there is a net profit of 5 per cent., a man with a salary of $500 a year receives $25; according to Rule II. of the By-Laws of this Baker Company, the net profits shall be divided between the preferred stock and labor in proportion to the earning capacity of each. This, in the hands of a shrewd lawyer, might be interpreted in various ways. Interpreted and carried out by the Baker Company, it means this: The money paid to stockholders as dividends and the money to labor as wages is in each case treated as for practical purposes earnings on capital. The capital of the stockholder is the total of money invested, the capital of the laborer is the total of his strength, his character, his skill, these three, muscle, brain, soul or self. Money capital is paid a yearly dividend of 5 per cent., man capital is paid the current wage of a given trade. Money capital and man capital being equals in the eye of the law of the company, it is a simple problem in percentage to reckon up the man capital of a laborer from his yearly wage. Divide by 5, multiply by 100. A $500 a year common laborer is a $10,000 man. The $2 a day steel company employee earning $600 a year would in the Baker Company in effect be a $12,000 man. Last year he would have received his $600 wages and his share as a capitalized man of the profits. This last was actually 82 7-10 per cent., or $496.20 to each $2 a day man who had been two years in their employ. The contrast between a year's profits of $496.20 earned and received and a $5 or $15 bonus bestowed is striking

Money capital draws its dividends once a year, the man capital once a week. The year's dividends to money having been paid, 10 per cent. of the remaining earnings is put aside into a rainy day sinking fund. The remainder is now ready for division between the two capitalists, the money and the man, "according to the earning capacity of each." The $20,000 stockholder, who for his ducats has received a $1,000 dividend, and the $20,000 mechanic, who for his skill, strength and character has received a $1,000 dividend, wages we say, meet now to divide the profits dollar for dollar on the earnings—that is, the capital of each—not a dollar of stock or money capital against a dollar of the earnings of man capital. One can see the virility of such an evolutionary idea.

The peculiar and beautiful point of it all is the lifting up of a man from the plane of a mere seller of muscle to the position of a capitalist. Business having been very flush the last four years, profits have been correspondingly large. After the 5 per cent. dividend on preferred stock and all wages and salaries were paid in January, 1900, 10 per cent. of the remaining surplus was paid into a sinking fund, and the remainder became subject to profit sharing between labor and capital, increasing the earnings of labor and capital that year 60.3169 per cent. In 1901, enlarging the sinking fund by 10 per cent. of the net earnings, the earnings on the common stock and profit sharing of labor were increased 82 7-10 per cent.

And what are the results on the community. One of the immediate and most substantial results is the building of homes by the men. At any time a man wishes to build a home the company will treat his common stock as in effect so much building loan association stock and loan money, at a reasonable interest. And one can find many beautiful cottages, which are profit sharing cottages, where it is possible for a man to "make a happy fireside clime for weans and wife." In the high school one feels the effects. The attendance at the high school of this town where labor has been capitalized is greater than that of many other near-by Wisconsin towns of double the population. There is no stern economic necessity that drives the boy into the shop and the girl to the office or store. In line with this general policy boys in school

are allowed to work on Saturday, earning $2 or $3 a day, and to work during the summer. The town has no open saloon. There are no evidences of pauperism. The wages paid are the current wage of the State for the work that is done. The general addition to the earnings of these Wisconsin men by the company adds to their standard of living a sum which is a tremendous gain to any one whose standard of living has been scaled to an average wage. There is a clean, straightforward, businesslike, well-kept look to the town. These are some results of real profit sharing, where the shop reacts upon the school, the home and the church.

HERRINGBONE GEARING WITH CUT TEETH.

La Construction Mecanique Internationale, January 30, 1903.

Toothed gearing is used throughout the entire world in the transmission of power in every kind of machinery. The chief points to be observed in the choice of gearing are: Strength, durability and efficiency. All of these requirements can be fulfilled in the manufacture of gears, only by obtaining a perfect adjustment of the teeth and the total absence of any play; so that the run of the gear will be uniform and smooth and that the friction and wear will be diminished, the jerks avoided, and the efficiency increased. These results are possible only by dividing and cutting the gears automatically by machinery. Cutting teeth in this way affords also the advantage that any faulty condition of the material will at once be detected.

A second important point which theory and practical experience teaches is, that in order to obtain in a gear the minimum loss of power the teeth must not be cut in straight lines, but in a helical direction; in this way only can sliding friction, the chief cause of loss of power and of wear and tear, be reduced. The helical teeth possess also the quality of transmitting motion in a uniform manner without any variation of the impulse received by the driven gear, and for this reason the helical toothed wheels are the only ones deserving the name of "wheels of precision" and to be employed in rapidly running sets of gears.

In the straight toothed wheels, the teeth come at once in contact, at the commencement of the locking process, over the full width of the gear with an initial pressure of about its full force. In the helical toothed gears the action is absolutely different; the power coming from the driving on the driven tooth gradually increases from zero to the maximum and diminishes again to zero. Consequently in a straight toothed wheel the whole amount of power acts on the top of the driven tooth and tends to break it with a lever-arm almost equal to the full height of the tooth; in spiral-toothed wheels, on the contrary the force reaches its maximum only after the lever arm has become much smaller; the strength of the spiral teeth is thus much greater than that of the straight teeth. For all of these reasons the spiral toothed wheels can transmit a much larger amount of power than the wheels with the same sized straight teeth and are, moreover, especially suited for very high speeds, such as are required for dynamos, electro-motors, ventilators, water wheels, etc.

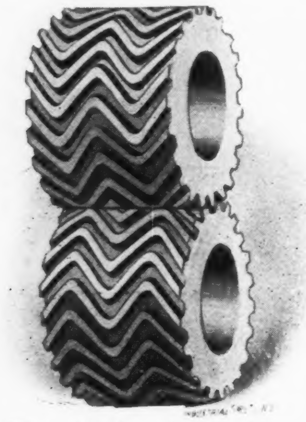


Fig. 1. Machine-cut Helical Gears.

In spite of the great advantages offered by the single spiral-toothed wheels, they are not convenient for the transmission of large quantities of power because they are subject to lateral pressure in the direction of the axis, this lateral pressure being in proportion to the power transmitted, considerable power is thereby lost. To avoid this lateral pressure and its harmful consequences we can divide the wheel in two equal parts; these two parts being cut with spiral teeth of opposite direction. We thus obtain double-spiral, angular or arrow-teeth, in which this lateral pressure cannot occur, for then the two opposite components balance each other. Consequently, in order to obtain in transmission of power the highest efficiency and perfect running, it is necessary that the teeth be carefully cut by machinery and have the shape of a double-spiral or arrow.

This result, which has never been reached by any previously constructed machine, is now possible by the new machines built by Citroen, Hinstin & Co., Essones, France, for cutting cylindrical, conical and hyperbolical gears with double-spiral or arrow teeth. Previously all double-spiral gears have been cast and, although they present great advantages as a consequence of the shape of their teeth, they are far from possessing the advantages of wheels with spiral teeth cut by machinery. The patterns for these teeth cannot be made with accurate spiral surfaces which are prescribed by theory, as molding would be very difficult, and the pattern could not be lifted from the sand. They are, therefore, made with obliquely placed teeth instead of with genuine and exact spiral teeth. The same difficulty in molding necessitates making these teeth with obtuse angles, and likewise the cutting machines heretofore used could cut only teeth of slight inclination, the lateral pressure being too great with teeth of greater inclination. In both cases it is impossible to obtain very smooth running, which is a characteristic of the real spiral wheels.

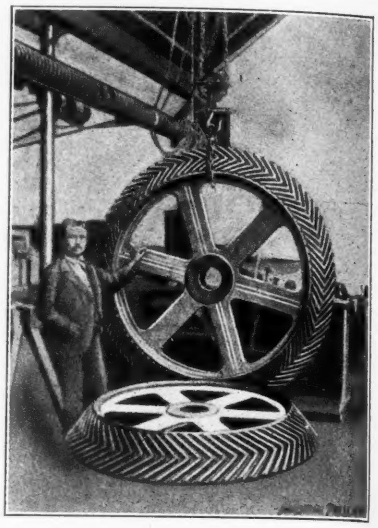


Fig. 2. Machine-cut Helical Bevel Gears.

The new machines obviate all of the above difficulties and permit the accurate and automatic cutting of teeth in a spiral shape; they even render it possible to make spiral gears with multiple arrows (Fig. 1), which would previously have been considered impossible. The spiral teeth are cut with a single stroke and with absolute accuracy. The gears cut by these machines correspond exactly to the theoretical calculations and can be made in any size from the smallest to 80 inches in diameter, for the bevel gears, and 100 inches in diameter for the cylindrical gears.

SUPERHEATED STEAM LOCOMOTIVES, SCHMIDT SYSTEM.

Bulletin of the International Railway Congress, January, 1903.

In view of the fact that the Prussian State Railway Administration have ordered 39 superheated steam locomotives, Schmidt system, and that there are already 29 in use on the Prussian railways, making a total of 66 soon to be in use, the subject of superheated steam locomotives assumes a world-wide interest. The trial of superheated steam locomotives on such a large scale, indicates that the Prussian Railway administrators are well satisfied with the economy and practicability of the system. While the system met with much opposition at the start the majority of Prussian locomotive builders are now convinced of its economy and practicability. They believe that its adoption will reduce all locomotives to one type, that is, the simple form opposed to the compound; also that there will not be so many classes required for different kinds of service.

At the November 12, 1901, meeting of the *Verein fur Eisenbahnkunde* Mr. Garbe read a paper on non-compound express locomotives with Schmidt superheaters. An abridged translation of this paper was published in the *Bulletin of the International Railway Congress*, January, 1903, from which we quote in substance:

To William Schmidt, Wilhelmshöhe, near Cassel, is given credit for having successfully applied the principle of superheating to stationary engines, and it was at his instigation that Mr. Garbe, privy councillor for construction, Prussian

State Railways, decided to study the question of the use of superheated steam for locomotives. The results in stationary practice had shown that the power of a steam boiler could be increased 25 per cent. and more if the steam was superheated 180 degrees F. over and above the temperature corresponding to the pressure of saturated steam. The remarkable phenomenon was also observed that, unlike saturated steam, superheated steam was a bad conductor of heat to such a degree that condensation was entirely avoided at ordinary short cut-offs. With saturated steam the loss from condensation often exceeds 30 per cent. It was quickly recognized these features would be of great advantage for locomotives as would allow a reversion to the simple type and still obtain better efficiency than is possible with the compound type, at the same time saving the complication and expense of the extra mechanism.

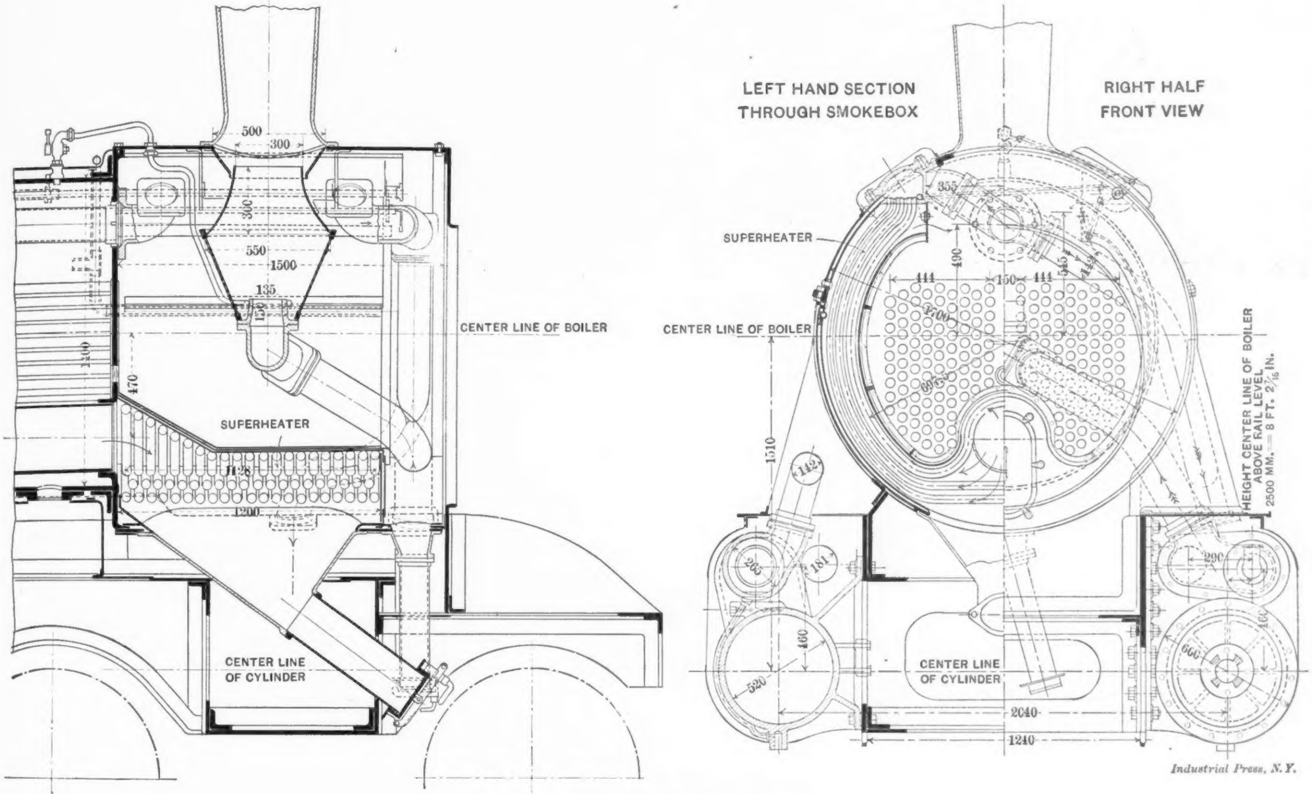
Mr. Schmidt calls steam superheated when it is heated to a temperature of at least 572 degrees F., that is, to more than 180 degrees F. over and above the temperature of saturated steam at the usual boiler pressures of from 140 to 170 pounds per square inch. Superheated steam at this temperature can be produced with a good apparatus with about 10 per cent. of the heat units developed in the firebox. The advantages are:

sures as low as 71 pounds, whereas the normal pressure is 170 pounds. The range is apparent. With large cylinders on saturated steam locomotives, short cut-offs cause condensation; short cylinders necessitate long cut-offs the moment the load exceeds a certain limit. It was shown in this way that the economical limits of power developed by the ordinary simple saturated steam engine, are very narrow, but for the superheated steam engine they are much broader. Hence the designer could adapt a locomotive to a much wider field of operation and make it possible for a railroad to do away with many of the locomotive classes now found absolutely necessary in economical railway operation.

Let d be the diameter of the cylinder, l length of stroke, D the diameter of the driving wheels, all in inches, and T the adhesion weight in short tons, then the dimensions of superheated steam engines, are so proportioned that,

$$\frac{d^2\,l}{D \times T} = \text{from } 3.64 \text{ to } 3.78$$

The paper is accompanied with details of construction and performance sheets that should be of considerable value to those interested in the subject. In regard to the details it



Schmidt Superheater for Locomotives.

1. The initial volume of steam is increased 25 per cent. 2. No condensation takes place in the cylinder even with the shortest cut-offs at which it is possible to work ordinary valve gears consistent with good practice. The Schmidt superheater is located in the smokebox, which has to be made somewhat larger than the diameter of the barrel to accommodate the nests of tubes. It is claimed that the addition of the superheater does not cost $2,000 additional more than a compound engine of the same power when the two types are fairly compared, etc.

The range of the superheated steam engine in the matter of power without impairing the economy was commented on. It was asserted that, provided the degree of superheat was sufficient, superheated steam at a pressure of say, 85 pounds, can give as economical results as saturated steam at 170 pounds. This being the case, it is possible to use cylinders of large diameters and to vary the steam pressure to the load without great loss of efficiency. The area of the piston should be such that with the superheater in action, the full power of the engine will be developed at cut-offs of 25 to 30 per cent. of the stroke. With a steam temperature of 572 degrees F. it is possible to run without condensation in the cylinders with pres-

may be mentioned in this connection that after many experiments it was found that a simple three-ring piston of the so-called Swedish type, gave the best results. Finally the author announced that he had in collaboration with Mr. Schmidt, worked out the plans for four different types of superheated steam engines, that would be able to deal with every kind of traffic on the Prussian State Railways, which may be taken as an indication of the practical value of the innovation so far as reducing the number of locomotive classes.

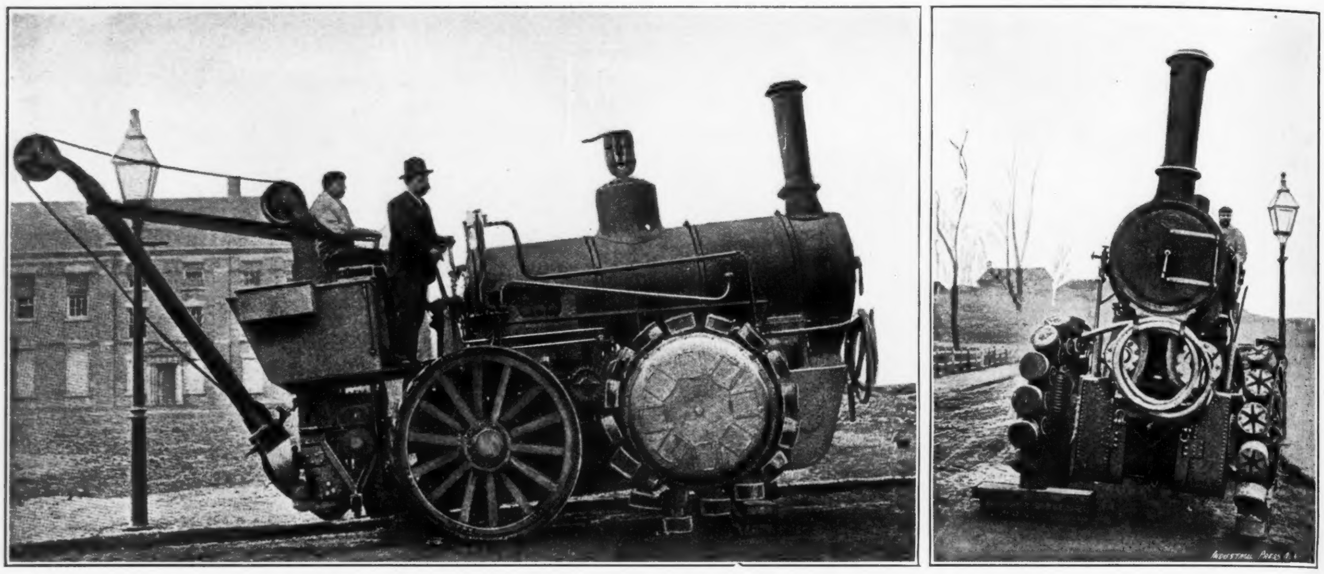
A NOVEL TRACTION ENGINE.

Transport (London). November 28, 1902. p. 512.

Longmans, Green & Co. have published a new book by B. J. Diplock, entitled "A New System of Heavy Goods Transport on Common Roads." The book is descriptive of a novel traction engine which is the invention of Mr. Diplock. The new traction engine has been dubbed "pedrail" by its inventor because of the peculiar stepping action of the drivers.

It is well known that the horse possesses a hauling power altogether out of proportion to its weight, and it is this the inventor has done his best to imitate, believing that the more nearly a mechanical tractive instrument on common roads

assimilates in principle to the structure of the horse the better will be the result. A horse puts down a foot, to which is attached a lever or leg, and the foot is mounted on an ankle-joint which enables it to twist to any reasonable angle to suit the surface of the road. To imitate this, Mr. Diplock, after many years' experimenting, has succeeded in producing the "pedrail." Practically, the "pedrail" places feet on the ground, each foot supporting a roller on edge, and a short rail, supporting the load, is levered along by the spokes over the rollers. Its general appearance is strikingly shown in Figs. 1 and 2. In an ordinary railway a rail is laid down and wheels are run over it; in the "pedrail," wheels, or rollers, are laid down and the rail is run over them. The sliding spoke represents the horse's leg, or lever, and each leg is pivoted by an ankle pivot to its foot. Fig. 3 shows how the required conditions have been carried out. *A* is a disc keyed or fastened to the driving axle; mounted on the disc are sixteen sliding spokes, and on the outer end of each spoke is a foot, *B*, pivoted by a ball and socket joint so that it can turn to any reasonable angle to suit the surface of the road. On one side of each spoke, and projecting beyond the disc, is a small wheel or roller, *C*. The spokes are drawn inward by springs (one to each spoke) on the other side of the disc, radiating from the center. These springs are not shown in the drawing.



Figs. 1 and 2. The "Pedrail"—a Novel Traction Engine.

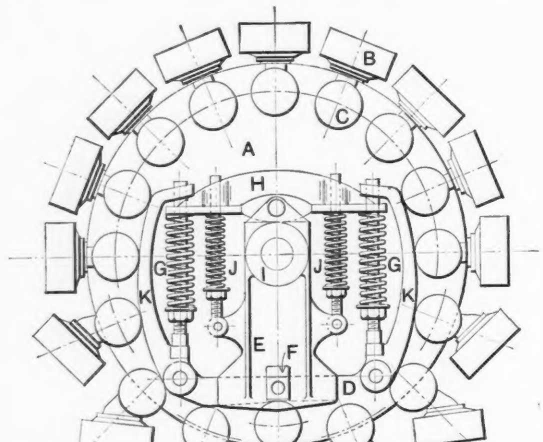


Fig. 3.

Mounted on the axle-box *I* is a rail *D* pivoted to a flat plate or guide *E*, forming part of the axle-box. The pivot of the rail is free to rise or fall in a slot *F* in the plate *E*. The rail *D* supports the engine or vehicle by two springs *G* pressing against a top lever, pivoted to the top of the axle-box *I*. The two inner springs *J* serve to steady the top lever. Two guides *K* are provided to lead the rollers *C* under the rail *D*. The whole of the levers and springs mounted on the axle-box *I* come flat against the disc *A* so that the rollers *C*, which project from the disc *A*, are arranged round the guides *K* and rail *D*, as shown.

The disc *A* carrying the spokes, rollers, and feet, revolves, but the axle-box *I*, with its dependent lever, guides, rail, and springs, does not revolve, with the result that a roller starting from, say, the top of the disc, strikes on the guide *K*, and gradually forces the sliding spoke outward, thereby enabling the foot to turn on its ankle-joint by its own weight as it comes down, and to drop with its flat surface on the road, the roller then passing under the rail as shown. The bottom of the rail is slightly arched, as shown by the dotted line, so that the varying height of the rollers caused by the spokes being sloped or upright is equalized and the soles of the feet present a uniform level surface to the road. By turning the railway upside down, the parts coming in contact with the road are broken up into a number of comparatively small feet, which can twist in varying directions as required. Previous attempts at endless railways have failed owing to the attempt to place the rail next the ground. The rail, presenting a long, cumbersome surface to the road, did not lend or adapt itself to the varying inequalities of the road surface, thus causing breakages.

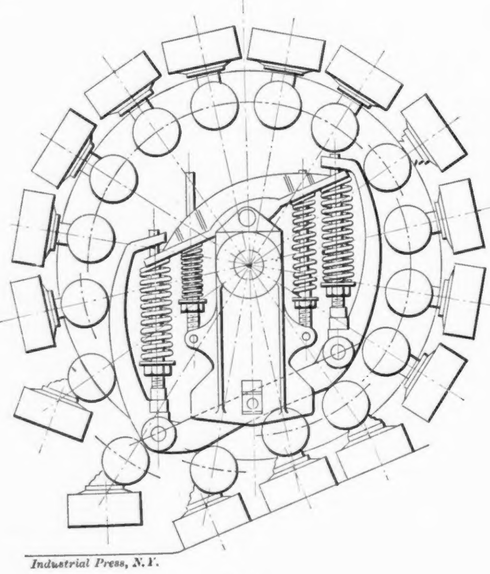


Fig. 4.

Prof. Hele-Shaw reports that severe tests made of the "pedrail" were quite amazing in the results. The engine tested had two of the "pedrail" wheels in front and two common traction engine wheels behind. The action was described as

practically noiseless, the most of the noise coming from the common wheels. The engine surmounted stones, planks and other obstacles with surprising ease and mud appeared to be no bar to its easy progressive motion, the contrast between the action of the "pedrail" wheels and the others being most marked. The engine shown in the photograph was equipped with only two "pedrail" wheels for experimental purposes, but the results have been so satisfactory that the other pair will be provided at once.

FRICTION OF BALL BEARINGS.

Abstract from Paper read by Mr. M. J. Golden before the American Association for the Advancement of Science.

Tests were made on hardened steel balls of 0.25, 0.3, and 0.5 inch diameter respectively at speeds varying from 200 to 2,000 rotations per minute. It was found that at speeds exceeding 2,000 rotations per minute, a shattering action was likely to occur in the bearing which quickly destroyed it. This action was especially noticeable at 5,000 rotations per minute, and above. The balls and races were destroyed by first becoming pitted, the pitting occurring in both. With heavy loads the balls failed by shearing into two parts. Any lubricant reduces the tendency to heat and shatter, but oil is better than grease.

Calculations from the figures taken during the test gave the coefficient of friction to be 0.00475, or less than one-half of one per cent.; though in a few of the tests the figure was found to slightly exceed one-half of one per cent. The friction was slightly greater with the smaller balls and at the higher speeds.

The formula deduced was gotten from so small a range in the sizes of the balls, and the degree of hardness in both balls and races was so nearly uniform in all those used, that it is not given to be used as a general formula, and only for what it may be worth after comparison with other formulas. The balls and races are to be of steel, thoroughly hardened and accurately ground.

Let the diameters be taken in inches, and the load in pounds: then

$D =$ diameter of the path of the balls on the races.
$d =$ diameter of the balls.
$L =$ load.
$F =$ friction.

$$F = L\left(0.005 + \frac{0.001}{d} + 0.005\,D\right)$$

WHEN IS AN ENGINE OVERLOADED?

Engineer. February 2, 1903. p. 143.

The editor remarks that engineers often complain that an engine is overloaded, and then pertinently asks:

"Upon what basis are overloads generally measured or figured? Is the extent of the overload determined with reference to a given point of cut-off, or a given number of horse power developed compared to the normal builder's rating, or to the effect of the load on regulation, or to the tendency to heat at the pins and bearings? Or is it based on a combination of these conditions; and if so, to what extent does each of the several conditions enter into the calculation, or to what extent are they taken into account when deciding questions of this kind?"

The power of a given engine depends upon the mean effective pressure and the piston speed; altering either, or both, changes the power developed. Some engines have carried so-called overloads with steam of a pressure so low that by doubling the pressure the engine would have been said to be underloaded. The question is, Where it is possible to thus increase the pressure, is the engine to be considered actually overloaded previous to the rise in pressure? If not, where is the dividing line between the pressures under which an engine is or is not to be considered overloaded? What is the proper piston speed to assume when figuring the horse power of an engine, and to determine the extent of overload, if any?

There has been in time past a feeble attempt to standardize a method of computing the horse power of an engine; that is, the nominal or rated horse power. Certain builders have adopted one method, other builders have adopted other methods, and engineers as a rule have methods of their own. To say that an engine is overloaded conveys but little information. The term "relatively overloaded" is no better. Relative to what? If there were a reasonable standard proposed, satisfactory to both builder and purchaser, there is little doubt but that it would be generally adopted, and we should hear less of overloaded engines, which are capable of carrying 25 per cent. more load by the mere turn of the hand. It happens oftentimes that the principal difficulties due to so-called overloads are traceable to a strenuous objection to running engines with more than the rated load. The lighter the load the easier it is to keep an engine in the habit of requiring little or no attention.

[The overload of an engine from a commercial and legal standpoint, is, of course, any excess over the builder's rating. An engine nominally rated at 100 horse power by the builder, is overloaded whenever it develops more than 100 horse power no matter if its proportions are so liberal that it can safely develop double the nominal rating. This, however, is only dodging the issue raised by the *Engineer*. An intelligent discussion of the question should lead to the adoption by the American Society of Mechanical Engineers and the Engine Builders' Association, of certain standard proportions and steam pressure as the basis of rating from which the normal safe load of steam engines can be calculated in a logical and scientific manner. The setting of such a standard should not be a difficult matter.—EDITOR.]

ELECTRIC SHOP DRIVES.

Discussion before the Engineers' Club of St. Louis, January 7, 1903.*

When electric shop drive was first advocated, the main advantage claimed was a large increase in efficiency over the old methods of belt and rope transmission. Of late, however, another, and, in my opinion, a greater advantage appears in the opportunity for increased shop output, resulting from the ability to operate the individual electrically-driven tool continuously at its maximum output. Shop managers are to-day keenly alive to the fact that, by means of electric drive, the output of individual tools may be easily doubled and sometimes trebled over that possible with the ordinary belt drive.

It is fair to say the discussion of electric shop drive is no longer one of merit, as compared with the old methods of transmission, but rather one of relative merit of the various electrical methods proposed. It is claimed on the score of efficiency alone that the best electric methods of to-day show an efficiency of 70 per cent., as compared with 20 and 25 per cent. by the old systems. Adding to this the possibility of double or treble output, the greater advantage of electric shop drive is such as to mean its rapid adoption in all branches of manufacturing.

Electric drive may be roughly classified under two headings—group and individual tool system. The former may be termed a compromise between the old and the best of the new.

In its best adaptations, group drive is so arranged as to have various classes of machine tools subdivided into groups of from 6 to 10 tools, each group being operated by a single motor. By such arrangement, the efficiency of shop drive is increased, roughly speaking, from 25 to 50 per cent. There is a further advantage over belt transmission from a single engine, in ability to operate any single group of tools entirely independent of the balance of the equipment. Independence of departments is fully secured by this means. A given group of tools may be completely shut down when not required, and a large loss of energy, otherwise unavoidable, cut off. This form of drive also permits of operation of any particular group of tools at night, with the main power plant shut down, provided auxiliary central station connection is possible.

The factory of the Wagner Electric Mfg. Co., of St. Louis, is one of a number of local examples of group electric drive. By means of reserve connection with outside central station service it is possible to run any special group of tools overtime, or all night, without operating the company's isolated generating plant.

Engineers agree, however, that the individual motor system

* The reader is also referred to the system of the Crocker-Wheeler Co., described in the September, 1902, number,—EDITOR.

is the ideal one where variable speed service of tools is necessary or desirable. In the group system variable speed is impossible, and the individual tools must be regulated for speed variation through inherent or cone adjustment.

Both group and individual drive systems may be arranged for either direct or alternating current motors. For all constant speed service the alternating current motor stands on an equal footing with the direct-current motor. In fact, by reason of its greater flexibility and inexpensive maintenance, the alternating-current motor for such work has a material advantage. The disadvantage of the alternating-current motor appears for all service requiring frequent starting and stopping, and wide speed variation. No entirely satisfactory system has yet been evolved by which speed variation comparable to that possible with the direct-current motor can be secured.

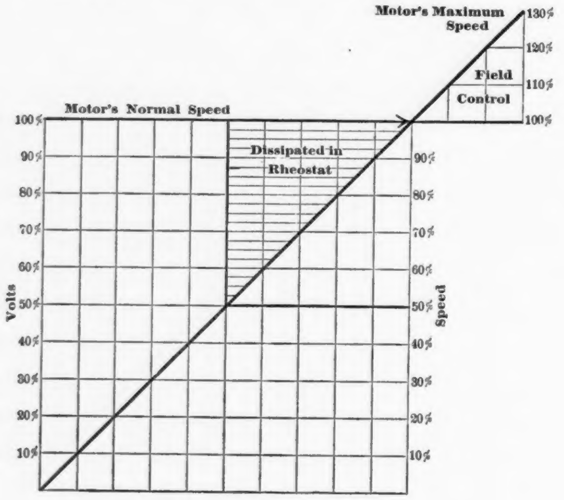


Fig. 1. Rheostatic Control.

The ideal alternating drive would be one having constant speed alternating-current motor, equipped with auxiliary mechanical device, where necessary, by which a wide range of speed variation could be secured smoothly and simply. Mechanical engineers are working on this problem, and such a system may come. I have seen one striking example of it in the shops of the Lodge & Shipley Machine Tool Co., at Cincinnati, where their "speed variator" is used.

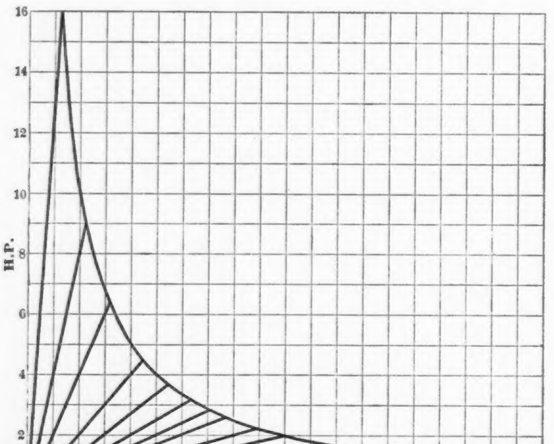


Fig. 2. Variation of Shunt Motor Capacity with Change of Speed Secured by Variation of Shunt Resistance.

With alternating-current motor drive, shop lighting from the same mains feeding the motors is possible and convenient, while with the prevailing methods for variable direct-current motor drive the shop lighting system is practically entirely independent of the motor service system.

The individual drive system may be generally classified under three headings: Rheostatic control systems; multi-voltage control, and special systems for special tools.

In the rheostatic control system the motor is of the well-known shunt type, supplied from a constant potential system of distribution. Speed variation above the normal speed of the motor is secured by the introduction of resistance into the motor shunt field circuit; speed variation below normal is secured by the introduction of resistance into the armature circuit. This is illustrated in diagrammatic form in Fig. 1.

The disadvantages of the system are its inefficiency when armature resistance is made use of for speed reduction, and variation of speed on a given armature resistance with variation of load. To overcome both disadvantages, motors have been designed capable of very wide variation in speed by variation of field resistance. A well-known motor designer stated in a recent discussion before the American Institute of Electrical Engineers that he had designed and built a motor capable of speed variation of one to three (simultaneous load variation not stated) on variation of field resistance alone. In the same discussion an equally well-known motor designer claimed that the normal motor was not capable of over 30 per cent. increase in speed, under full load, by field resistance variation.

I think general practice is to confine speed variation, by weakening the shunt field to 30 per cent., and any motor capable of greater variation can hardly be termed a standard motor. The limit of such variation is determined by commutator sparking. A motor of given capacity may be operated, of course, at much reduced capacity for speed variation of 10 to 1. The reduction of capacity, with increase of speed, in this case, is illustrated by the curve, Fig. 2. This curve fairly represents the variation in one of the best known makes of direct-current motors. For example, a 10 H. P. motor, operating normally at a speed of 200, will have an output of 1 H. P. only, at a speed of 2,000; speed variation being secured entirely by weakening of the shunt field.

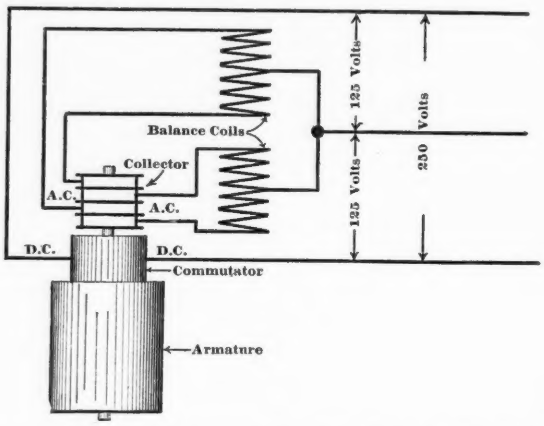


Fig. 3. Westinghouse Three-wire System for Variable Speed Control.

Multiple Voltage System.

There are several of these systems. The Westinghouse and the General Electric Companies advocate a three-wire system, as illustrated in Fig. 3. Their usual direct-current generator is provided with a set of collector rings, these collector rings being connected to the armature winding in such a way as to establish an exact two-phase relation between the potentials of the two pairs of collector rings. By means of choking coils connected as shown, the neutral wire of the three-wire system is exactly and constantly maintained, irrespective of load, at zero potential relative to the outside wires.

In connection with this three-wire system, the individual tool is equipped with a standard 250-volt shunt motor, and speed variation is secured in two ways: First, by running the armature either on 250 volts (normal speed condition); or by running it on 125 volts (half normal speed condition). For any speed desired between normal and half normal, shunt field resistance is introduced. If I understand the system correctly, the shunt motor is capable of 100 per cent. speed variation by variation of shunt resistance when the armature is on half voltage—and correspondingly at half load. If speed above normal full speed is required, shunt resistance is again introduced.

The Bullock Electric Mfg. Co. advocate a system as illustrated in Fig. 4. A generator, standard in every respect, is supplemented by a small motor-generator set, the design of

which is such that a four-wire system of distribution is established, providing for six different voltages upon which the motor armature may be operated without the use of armature resistance. The form of motor used is the standard shunt wound type. Without the use of field resistance, six speeds may be secured, corresponding in ratio to the ratio of the voltages supplied by the four-wire distribution system. By means of shunt resistance any speed intermediate to that possible with the several armature voltages may be secured. The motor generator set is so proportioned as to take care of

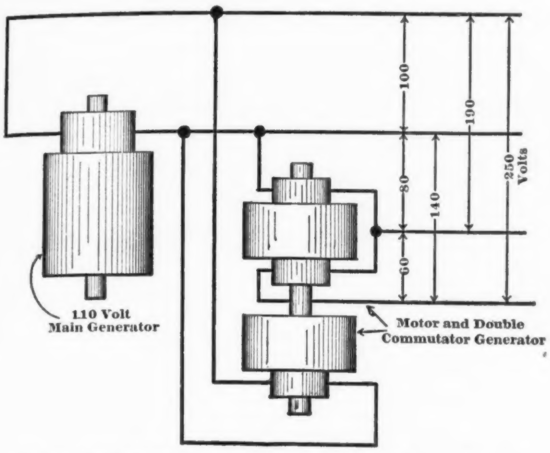


Fig. 4. Bullock Electric Mfg. Co.'s Multiple Voltage System.

the unbalanced load. This system is also adaptable to three-wire distribution, where less speed variation is required, and in the event of three-wire distribution an increased amount of field regulation is introduced. This three-wire distribution differs from the Westinghouse and General Electric system in that the voltages on the two sides of the intermediate wire differ, thus giving three distinct pressures instead of two. The Bullock system represents the multiple voltage idea carried to its fullest development, and is the extreme of present commercial systems, from the ordinary rheostatic control system. The difference between these systems, from the standpoint of efficiency, is illustrated in Fig. 5, as plotted from the test results on a 25 H. P. motor.

Another form of variable speed equipment is advocated by

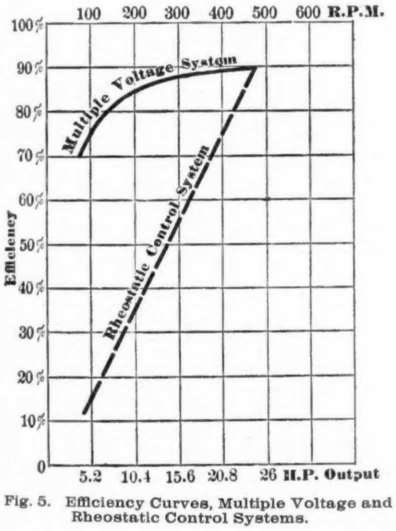


Fig. 5. Efficiency Curves, Multiple Voltage and Rheostatic Control Systems.

the C. & C. Co., of New York City. In this case the motor is special, being provided with two entirely independent armature windings. On normal speed operation the two armature windings are connected in parallel, the field winding being in shunt. For half speed the two windings are connected in series; intermediate and excess speeds are secured by a combination of armature and field resistances.

* * *

There is a general opinion that concrete is damaged by freezing; but it has been ascertained that concrete floor arches that have been frozen solid, thawed out, and frozen again, were in no way changed, but when finally thawed and dried out were as strong in every way, as far as could be determined, as those which were not frozen.

NEW NO. 3 MILLING MACHINE.

The half-tone, Fig. 1, illustrates a new milling machine that has just been brought out by the R. K. LeBlond Machine Tool Company, Cincinnati, Ohio. The principal novelty of the machine is the use of double friction back gears. The advantages derived from this type of back gearing are: The cone

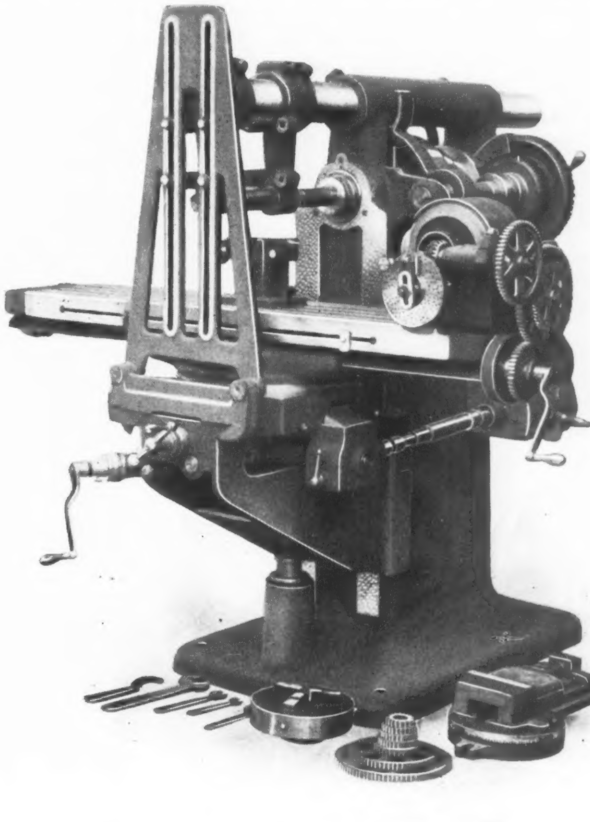


Fig. 1. Le Blond No. 3 Universal Milling Machine.

can be of better proportion than when single back gears are used; a greater number of spindle speeds can be obtained; higher belt speeds and better belt contact are obtainable, and the drive is twice as powerful as on the regular machine.

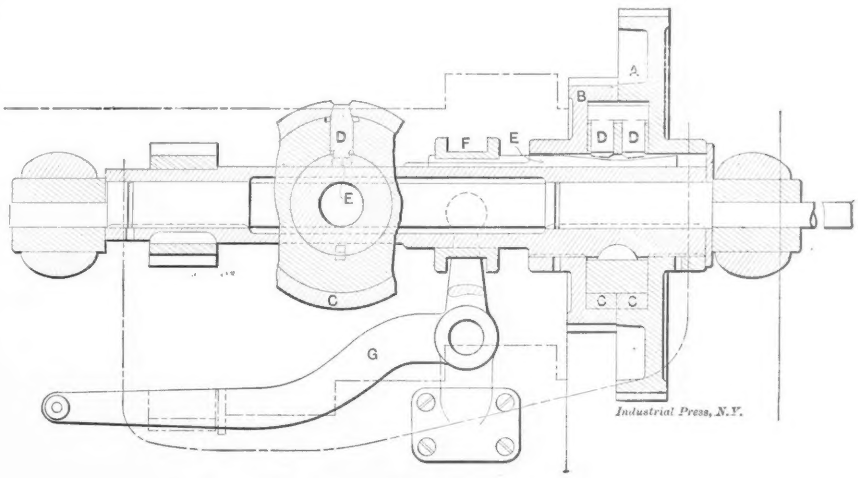
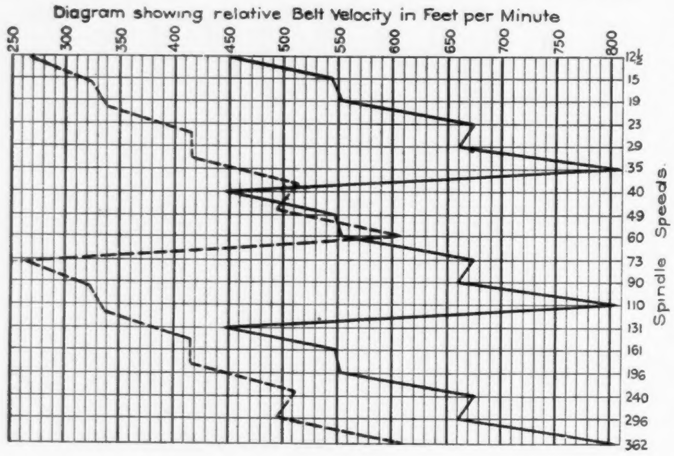


Fig. 2. Arrangement of Friction Back Gears.

The construction of this back gear is shown very clearly by the drawing, Fig. 2. It consists of a ring, *C*, that is opened by the plug, *D*, the sides of which are tapering. This plug is forced up with a taper key *E*. The friction ring is made to snap tight on a spool, so that when released there is absolutely no friction on the gear, as the band comes tightly to its place on the spool. The wedge or key is carried by a yoke *F*, which in turn is operated by the lever *G*, shown at the side of the column. The special advantage of making the friction this way is that its power is multiplied a good many times before it reaches the spindle; since this friction merely drives the pinion on the back gear quill, which in turn drives the face gear.

Comparing the relative spindle power of a double back geared machine with that obtained by the ordinary four-step cone and single back geared machine, the large step of the spindle and countershaft cones being the same in both instances and both machines calculated to give a range of spindle speeds of from 12½ to 362 revolutions per minute, we find that the countershaft on the double back geared machine runs at 180 and 220 revolutions per minute, while on the single geared machine it runs at 135 and 166 revolutions



The Broken Line indicates Belt Speeds on the Single Geared Machine.
The Full Line indicates Belt Speeds on the Double Back Geared Machine.

Fig. 3.

per minute, thus giving the double geared machine a gain in countershaft speed, or power, of 33 and 30 per cent., respectively.

The cone diameters on the double back geared machine are 13, 10¾ and 8½ inches. On the single back geared machine they are 13, 10 13-16, 8⅝ and 6 7-16 inches in diameter. This gives an increased diameter on the smallest cone step of the double back geared machine of 2½ inches, amounting to 32 per cent. increased belt contact. This pertains as well to the small step of the countershaft cone.

The relative belt speeds obtained are shown graphically in the diagram, Fig. 3. The broken line indicates those on the single geared, and the solid line on the double geared machine. It will be seen that when both machines are running at the

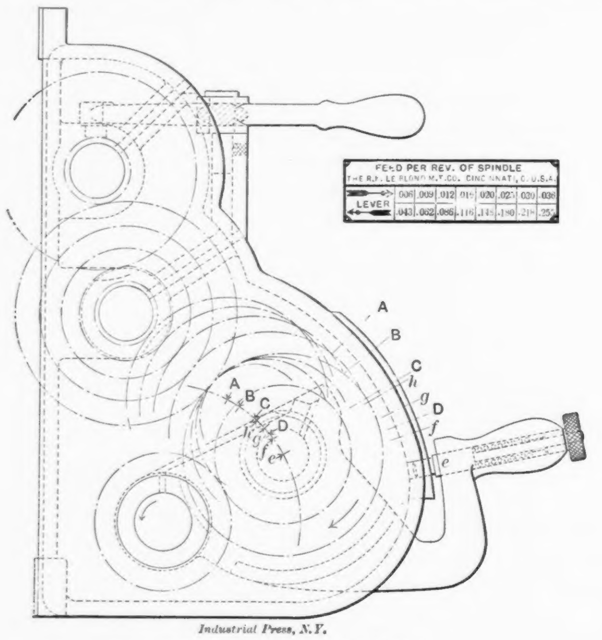


Fig. 4. End View of Feed Box.

slowest speed of 12½ R. P. M., the double back geared machine has a cone belt velocity of 447 feet per minute, while the single back geared machine has a velocity of 267 feet per minute, showing a gain for the double back geared machine of 70 per cent. in power. This proportion is maintained until we reach 35 R. P. M. when, engaging the low ratio of back gear, the double back geared machine reduces the belt speed to about that of the single geared machine, from which point the belt speed then increases in favor of the double back geared machine until at 75 R. P. M. there is a difference in the belt speed of 390 feet, or a gain of 150 per cent. When the machines are running on the open belt the double back geared machine has an increased belt speed varying from 70 to 200 feet, as will be seen from the diagram.

The ratio of the back gears is also much more favorable on the double back geared machine. Calculating the back gear ratio so as to give an even grade of speeds running in geometrical progression from 12½ to 362 R. P. M., we get a back gear ratio of 3.3 and 10.34 on the double back geared machine, and 6.2 on the single back geared machine, amounting to an average increase of 74 per cent. in back gear power. Another advantage of the double back geared machine is that but one-third of the speed changes are obtained with the open belt while on the single geared machine one-half of the changes are obtained in this way. With the countershaft and double friction back gears, four changes of speed are obtained without shifting a belt, a lever at the side of the column enabling the changes to be made without stopping the machine. When the cone drive is used the back gears can be thrown out of mesh the same as on any ordinary back geared machine. The cone and spindle drive are proportioned to give the correct cutting speed for eighteen different diameters of cutters, ranging in size from ½ to 15 inches, with a speed of from 12½ to 362 revolutions per minute. These cutter sizes are figured for

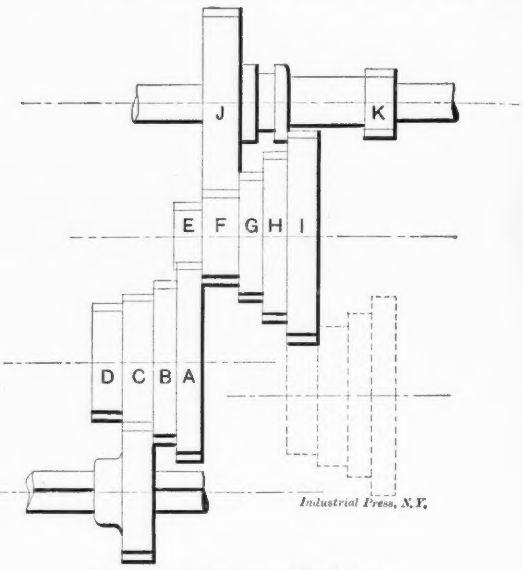


Fig. 5. Arrangement of Feed Gears.

a cutting speed of 50 feet per minute, which, under ordinary conditions, is the rate at which cast iron can be milled on these machines.

Another important new feature of these machines is the feed change box, an end view of which is shown in Fig. 4. The feeds are arranged in geometrical progression ranging from .006 inch to .255 inch per revolution of the spindle. The box is composed strictly of spur gears, and the transmission from the spindle to the box is through spur gears. Any feed can be instantly obtained by the movement of a single lever, while an engraved plate attached to feed box indicates the feed obtained. The lower lever gives a fine and the upper lever a coarse graduation of feed. Each handle is entirely independent of the other and can be worked separately or in unison. With the upper lever in the first position we get all feeds from .006 inch to .036 inch, or the range generally used for direct cone drive. With the upper lever in the second position we get all feeds from .043 inch to .255 inch, or the feeds used when the spindle is back geared.

The arrangement of the feed box gears will be clearly seen by reference to the diagram, Fig. 5. On the high spindle speeds and high feeds the drive is through pinion K. On slow speeds when heavy cuts are taken the feed is through gear J, increasing the feed and power of the feed box seven times. By meshing each of the gears on the lower cone with the gear I on the upper cone, and each of the gears on the upper cone with the gear A on the lower cone, eight changes of speed are obtained. By moving the gear K into mesh with the gear I, eight more changes are obtained.

NOTES OF TRAVEL.

A UNIQUE ITALIAN PUMP AND HOW ITS PHOTOGRAPH WAS OBTAINED.

Editor MACHINERY:

In the neighborhood of Naples and Pompeii as well as the region lying between them, each of the small farms or vegetable gardens is provided with a pump for irrigation. The form is unique and nearly the same in every case. The one illustrated is typical of them all. There is a broad, shallow well with a low wall in the front and extending back a short distance on the sides. The back part is arched over, and between the front and back the walls are carried up high.

One end of a horizontal wooden shaft rests on the highest part of the wall in a suitable bearing for allowing it to rotate. The other end of the shaft is supported by a cross-beam between a stone pillar at one end, and a wooden post or another stone pillar at the other. A bucket-chain hangs over a chain-wheel on the shaft and down into the water. In the illustration the buckets are of iron. They are suspended by two endless ropes.

The place where the greatest variation from this particular form of pump occurs is in the buckets and their suspension member. In a few cases a broad band is used instead of the two ropes. This band is made of cloth or woven grass. The buckets used on this band are sometimes in the form of an Italian slipper with the high-heel removed—the kind of slipper that covers only the front of the foot and has a sole extending back to the heel. Other forms resemble more closely the baskets used by the American Indian squaw for carrying her papoose. These buckets are made up of wood, leather and grass or straw. Each bucket is attached to the band so that the toe, in the slipper form, is down on the water-carrying side, and on the down side of the band it is, of course, inverted. When the chain-wheel is turned, the water carried up by the buckets is emptied out as they pass over the top of the wheel. It runs into a stone channel or canal on the top of the arch. The long back extension of the slipper-shaped bucket is for carrying the water well over into the canal. The latter extends out through the gardens as a stone structure with outlets along its sides that may be opened or shut at will.

The device for driving the horizontal shaft is primitive in the extreme. A wooden pin gear on it engages with a crown gear on a vertical shaft. The teeth of the crown gear are mere wooden pins roughly rounded and sharpened almost to a point. The shaft of the crown gear rests on a large stone at the bottom, and the upper end is supported by the same beam that carries one end of the horizontal chain-wheel shaft.

In only one pump out of some fifty or more that were seen was any other form of gears used. In this single exception there were cast-iron bevel gears of modern form.

The motive power for pumping is furnished either by a man or woman, or by a small horse or donkey. Small holes for traces are provided in the two down projecting pieces near the end of the long driving arm.

The securing of the photograph occupied a morning full of interesting occurrences. A great number of the pumps had been noticed the day before during a round trip between Naples and Pompeii on the steam railway. The speed of the train, which covered the twelve miles in an hour and a quarter, was not too high to permit rather close inspection of objects along the way, including pumps and wells. The latter two were so interesting that a decision was made to secure a photograph the next day, if possible. Accordingly, a horse street car was boarded in the morning on a line leading from Naples toward Pompeii. A lookout was kept between the houses for near gardens. The speed of this car, with its diminutive horses, allowed this very satisfactorily. Finally, at Portici, gardens were seen, so the car was halted. Upon our starting to alight, one of the horribly deformed, but wonderfully agile beggars so common in Italy, noticed that his legitimate prey, foreigners, was at hand. This particular pest had one leg bound up before him across his chest. Otherwise he appeared strong and healthy. He traveled on one foot and two hands. The street was wide and the pavement was covered half an inch deep with filth of the consistency of mortar. But he came from the curb to the car with great speed and placed himself immediately before the step, so that it was impossible to get off without stepping against him. This was highly undesirable on account of the condition of his clothes. Having learned the importunateness and persistency of his class, a quick turn was made to the opposite side of the platform. But he made the change of position to the other step with the quickness of an active dog, and was there in time to receive his victims. A vigorous intimation that the point of an umbrella would be used if he did not move aside, persuaded him to grant free passage.

A large macaroni factory occupied one side of the street leading back to the fields. In front of it the sidewalk, on the main street, was filled with the newly-made food hung out to dry. Cane poles resting on wooden horses formed the necessary supports. These poles were some three feet from the ground, and close together. The moist macaroni hung down nearly to the ground. Swarms of flies were sampling the goods and disporting themselves over it. No dogs were tasting it at the instant, but some were in the immediate neighborhood. The suspended strings act well as a flybrush for a dog passing through them, and the moist tubes must tempt his taste. The whole was not conducive to a relish of Italian macaroni.

A Unique Italian Pump.

The side street was paved as far back as the rear of the macaroni factory; and it also had curbing and sidewalks. One of the walks was deep mud. The other was not bad, comparatively, in this feature, and was fairly safe in daylight when a sharp lookout before was kept. But it would be wiser to wade in the mud at night, than to take the risk of falling into one of the numerous and large, deep holes with which it was well supplied. There was a large sewer under the walk, with numerous manholes. These were square and nearly two feet both ways in the opening. The frame and cover were both of stone. The cover was thick and heavy. They were all there, but had been dropped through the opening into the sewer, possibly for safekeeping. In that position they prevented too swift a current with its probable danger to the walls. The adoption of a square manhole for such a purpose and construction is an indication of the good engineering that prevails in the country, except the extreme northern part.

The street improvements stopped short at the rear end of the factory. Here the street dropped abruptly down a few feet and became mere ridges of mud.

A path leads from here to the pump, and a peasant girl was at work near this path, who graciously agreed to having the pump photographed as soon as our wants were made known. By the time the most suitable point of view was determined, five other persons had arrived on the spot—the man at the pump, a younger man, and three Italian maids. They were all much interested and pleased by the tiny image of the pump in the finder of the camera. Two looks apiece were necessary to gratify them. Then they insisted that we must see the pump operating. It had been wet weather for

some time, so the pump had been idle. An end of a clothes-line had been tied to one of the pins in the crown. This line was very long and filled with fresh washed white clothes except a short portion between the pin and a tree close to the line. The line had to be loosened in order to turn the pump. So all Italian hands set to work to transfer the fastening from the pin to the trees. This was done in what seemed a very neat and satisfactory manner, and the work was proceeding smoothly, when suddenly there arose a loud and angry clatter at the opposite end of the line where it was attached to a house. A glance in that direction showed about half the clothes lying flat on the newly upturned earth. A prop had fallen during the process of transition of the anchorage. An old woman was approaching, shaking her fist at the party, and pronouncing anything but blessings upon their heads. The photograph of the pump was taken immediately after.

There was but little time left for returning to Naples and catching a train to Rome. So the amateur photographers made haste to depart. Arriving again at the main street, no car could be seen. A one-horse carriage (vetture) was at hand, however. It might more truly be called a half-horse carriage, the horse is so small. The driver cheerfully agreed to take the two of us home, a distance of more than six miles, for one lira (twenty cents). It took him an hour and a quarter to do it, traveling faster than the ordinary Neapolitan vehicle of the same class. He was satisfied with the lira when it was given him at the end of the journey, and saluted politely without even a hint of a fee for a drink. But his fares were American, and could not see him go with this absurdly small sum for the service, as most of his own countrymen would undoubtedly have done. He had guided his nag carefully around the numerous holes and pitfalls in the way, by judicious use of the reins and tiny crossbar over the nose of his tiny beast.

None of the horses for this public service has a bit in its mouth in Naples. Nothing is placed in the mouth. A metal bridge, usually brass, passes over the bridge of the nose, a considerable distance up from the end. It is something of the nature of the bridge of a pair of spectacles. The head harness is something like a halter, with this bridge in place of the nose strap. A six to eight-inch bar extension is on each end of the bridge. These stick out on each side of the horse's head, and the reins are attached to their extremities. The animals are so small that they can be readily controlled with this harness. FORREST R. JONES.

Manchester, England.

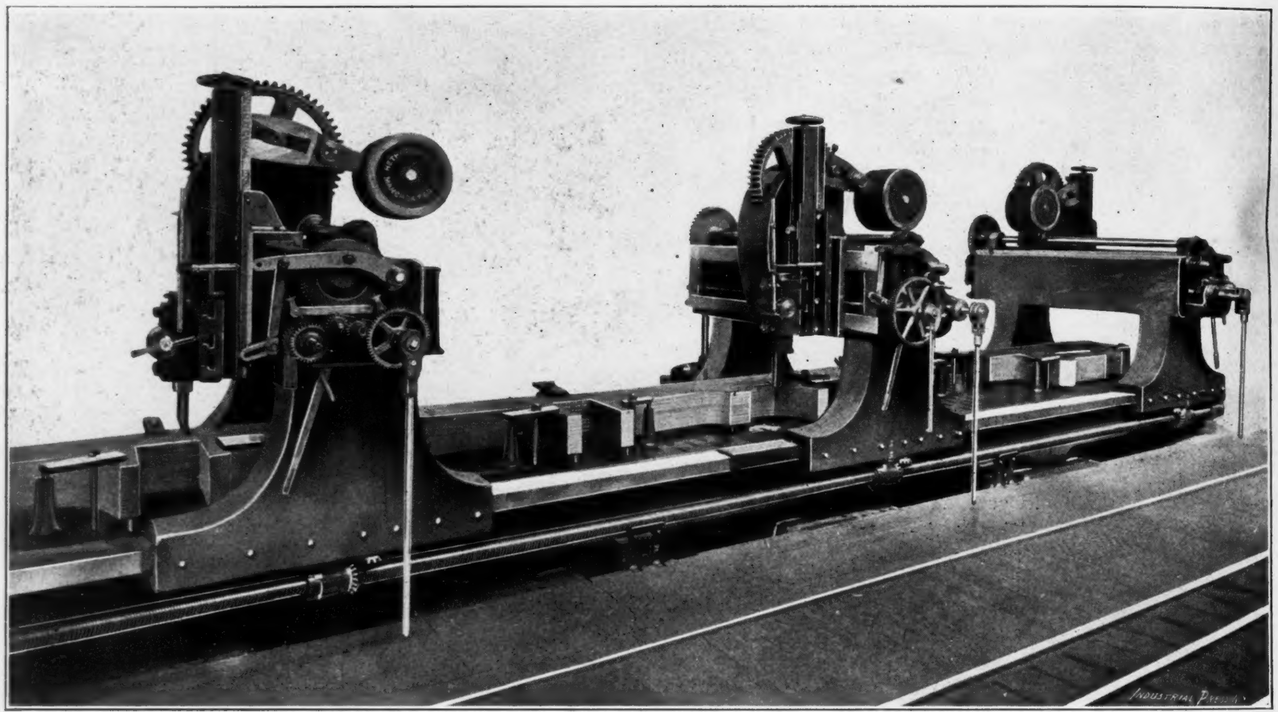
AN ENGLISH LOCOMOTIVE FRAME-PLATE SLOTTING MACHINE.

The illustration presented herewith shows a very interesting machine of English construction that is used for slotting and drilling locomotive frame-plates. It is usually fitted with an electric motor-driven countershaft and takes about 25-horse power in ordinary working conditions. The bed and table are of box pattern, planed on the top and sides and provided with suitable bolt slots. The cross slide and uprights or heads are also of box pattern cast in one piece. They are planed and fitted to the bed and arranged, with hand and variable self-acting feed along the bed by means of cam levers, cut change wheels, miter wheels, revolving gun metal nuts and two square thread steel screws of large diameter. One of these is on each side of the bed supported at intervals by tumbler bearings. The longitudinal and transverse feed can be worked separately, or the two coupled, by swing frame and change wheels, giving a self-acting diagonal transverse for slotting outside the axle box horns and cylinder seatings.

The planed carriage is fitted to cross slide with hand and variable self-acting feed across the bed. The front face is fitted with a balanced vertical ram or tool slide adjustable vertically by means of a hand wheel, square thread screw and gun metal nut with locking bolt. The front face is provided with T slots, tool-holders and a removable self-acting tool box for slotting radii. The length of stroke is 14 inches, and there are three heads on the machine tool shown. The length of the bed over all is 36 feet and the total width 6 feet 1 in., while the width between the uprights is 5 feet 1 in. and 34 feet is the length of the plates that can be slotted. The width of the plates which can be slotted is 5 feet and the height from the face of table to the underside of cross slide is 2 feet 6 inches.

The driving is by means of a three-cone pulley of large diameter for wide belt of high velocity. There are two pairs of bevel gears, spur gear and link motion giving quick return stroke. Each head can be started and stopped independently by means of friction clutch coupling operated by a lever attached to the upright.

The diameter of the steel spindles for drilling is 2½ inches and the machine is designed to bore in diameter up to 10 inches and in depth up to 15 inches. The drilling, tapping and studding attachment is fitted to the back of each cross slide, consisting of cross slide planed to receive spindle slide or carriage, adjustable transversely by hand wheel, pinion



Machine for Slotting and Drilling Locomotive Frame-plates.

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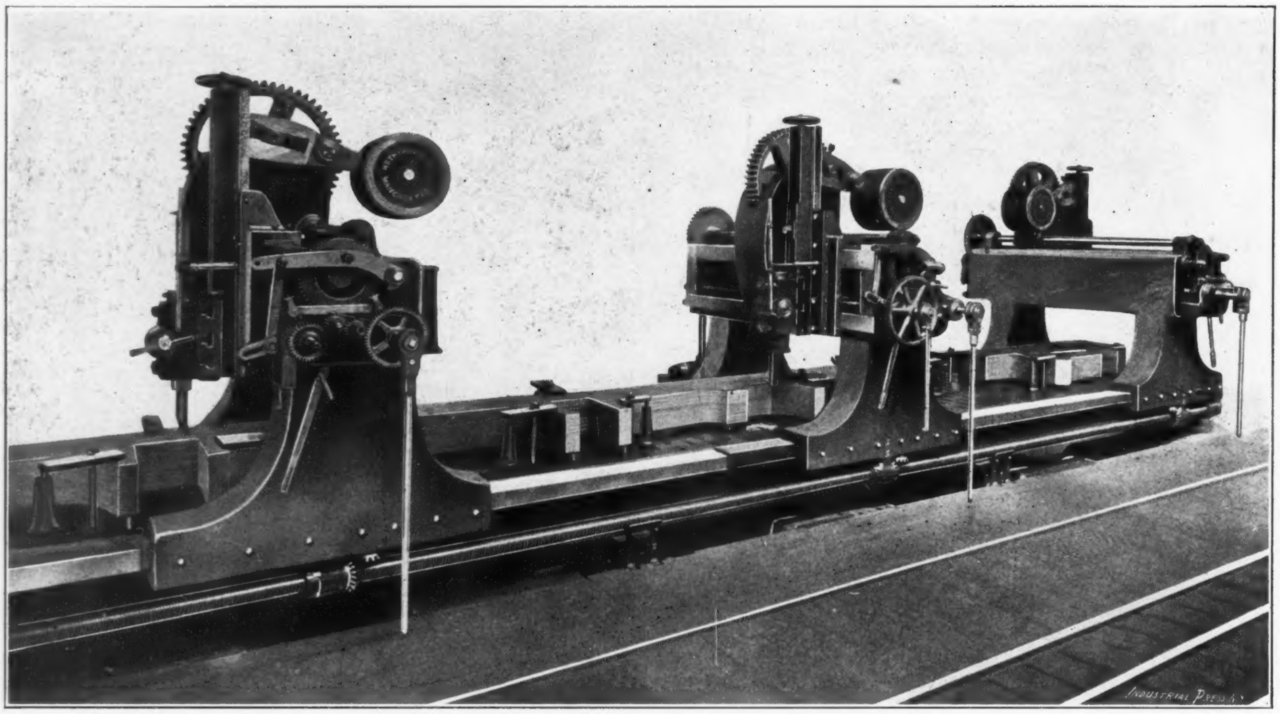
The diameter of the steel spindles for drilling is $2\frac{1}{2}$ inches and the machine is designed to bore in diameter up to 10 inches and in depth up to 15 inches. The drilling, tapping and studding attachment is fitted to the back of each cross slide, consisting of cross slide planed to receive spindle slide or carriage, adjustable transversely by hand wheel, pinion



Machine for Slotting and Drilling Locomotive Frame-plates.

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COMPARISON OF TWIST DRILL (MORSE) AND DRILL ROD (CRESCENT OR KIDD-STUBBS) NUMBER SIZES.

Number.	Drill.	Rod.	Number.	Drill.	Rod.
1	.2280	.2270	31	.1200	.1200
2	.2210	.2190	32	.1160	.1150
3	.2130	.2120	33	.1130	.1120
4	.2090	.2070	34	.1110	.1100
5	.2055	.2040	35	.1100	.1080
6	.2040	.2010	36	.1065	.1060
7	.2010	.1990	37	.1040	.1030
8	.1990	.1970	38	.1015	.1010
9	.1960	.1940	39	.0995	.0990
10	.1935	.1910	40	.0980	.0970
11	.1910	.1880	41	.0960	.0950
12	.1890	.1850	42	.0935	.0920
13	.1850	.1820	43	.0890	.0880
14	.1820	.1800	44	.0860	.0850
15	.1800	.1780	45	.0820	.0810
16	.1770	.1750	46	.0810	.0790
17	.1730	.1720	47	.0785	.0770
18	.1695	.1680	48	.0760	.0750
19	.1660	.1640	49	.0730	.0720
20	.1610	.1610	50	.0700	.0690
21	.1590	.1570	51	.0670	.0660
22	.1570	.1550	52	.0635	.0630
23	.1540	.1530	53	.0595	.0580
24	.1520	.1510	54	.0550	.0550
25	.1495	.1480	55	.0520	.0500
26	.1470	.1460	56	.0465	.0450
27	.1440	.1430	57	.0430	.0420
28	.1405	.1390	58	.0420	.0410
29	.1360	.1340	59	.0410	.0400
30	.1285	.1270	60	.0400	.0390

NOTE.—Drill and rod in letter sizes correspond in diameter.

Compiled by E. C. Howe, Brooklyn, N. Y.

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CONSTANTS FOR FINDING DIAMETER OF BOTTOM OF THREAD.

Threads per inch.	U. S. Standard Constant	V Thread Constant.	Threads per inch.	U. S. Standard Constant.	V Thread Constant.
64	.02029	.02707	16	.08118	.10825
60	.02165	.02887	14	.09278	.12357
56	.02319	.03093	13	.09992	.13323
50	.02598	.03464	12	.10825	.14433
48	.02706	.03608	11	.11809	.15745
44	.02952	.03936	10	.12990	.17320
40	.03247	.04330	9	.14433	.19244
36	.03608	.04811	8	.16237	.21650
32	.04059	.05412	7	.18555	.24742
30	.04330	.05773	6	.21650	.28866
28	.04639	.06185	5½	.23618	.31490
26	.04996	.06661	5	.25980	.34650
24	.05412	.07216	4½	.28866	.38488
22	.05904	.07872	4	.32475	.43300
20	.06495	.08660	3½	.37114	.49485
18	.07216	.09622	3	.43333	.57733

C = constant for number of threads per inch.
D = outside diameter.
B = diameter at bottom of thread.

$$B = D - C$$

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...tables, da... or other information that shall be accepted for one of these data sheets.

These data sheets are intended to be cut into four sections, 6 x 9 inches in size, as indicated by the straight lines. They may then be bound into note book form for convenient reference by means of staples inserted in holes punched at the points indicated.

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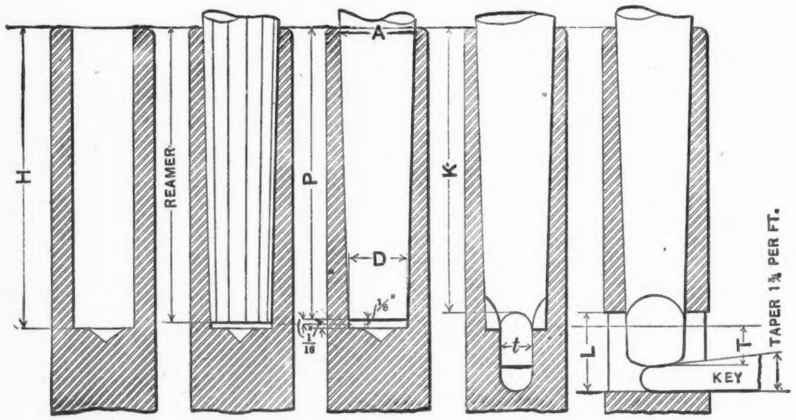
BROWN & SHARPE STANDARD TAPERS.



Number of Taper.	Diameter of Plug at Small End.	Diameter at End of Socket.	Standard Plug Depth.	Depth of Hole.	End of Socket to Keyway.	Length of Keyway.	Length of Tongue.	Thickness of Tongue.	Width of Keyway.	Taper per Foot.
	D	A	P	H	K	L	T	t	W	
1	.20	.239	15/16	1 1/16	15/16	3/8	3/16	1/8	.135	.500
2	.25	.299	1 3/16	1 5/16	1 11/64	1/2	1/4	5/32	.166	.500
3	.312	.385	1 3/4	1 7/8	1 23/32	5/8	5/16	3/16	.197	.500
3	.312	.395	2	2 1/8	1 31/32	5/8	5/16	3/16	.197	.500
4	.35	.402	1 1/4	1 3/8	1 13/64	11/16	11/32	7/32	.228	.500
5	.45	.523	1 3/4	1 7/8	1 11/16	3/4	3/8	1/4	.260	.500
6	.50	.599	2 3/8	2 1/2	2 19/64	7/8	7/16	9/32	.291	.500
6	.50	.635	3 1/4	3 3/8	3 11/64	7/8	7/16	9/32	.291	.500
7	.60	.725	3	3 1/8	2 29/32	15/16	15/32	5/16	.322	.500
7	.60	.766	4	4 1/8	3 29/32	15/16	15/32	5/16	.322	.500
8	.75	.898	3 9/16	3 11/16	3 29/64	1	1/2	11/32	.353	.500
9	.90	1.066	4	4 1/8	3 7/8	1 1/8	9/16	3/8	.385	.500
10	1.0446	1.260	5	5 1/8	4 27/32	1 5/16	21/32	7/16	.447	.5161
10	1.0446	1.289	5 11/16	5 13/16	5 17/32	1 5/16	21/32	7/16	.447	.5161
10	1.0446	1.312	6 7/32	6 11/32	6 1/16	1 5/16	21/32	7/16	.447	.5161
11	1.25	1.531	6 3/4	6 7/8	6 19/32	1 5/16	21/32	7/16	.447	.500
12	1.50	1.796	7 1/8	7 1/4	6 15/16	1 1/2	3/4	1/2	.510	.500

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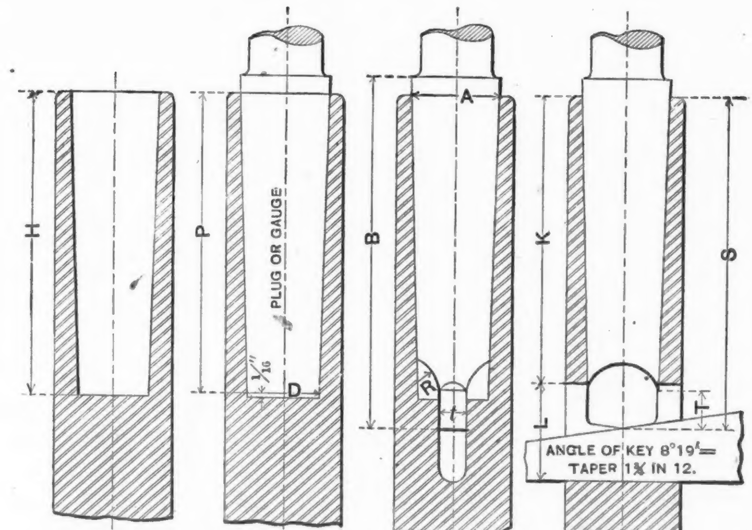
MORSE STANDARD TAPERS.



Number of Taper.	Diameter of Plug at Small End.	Diameter at End of Socket.	Standard Plug Depth.	Whole Length of Shank.	Depth of Hole.	End of Socket to Keyway.	Length of Keyway.	Length of Tongue.	Thickness of Tongue.	Width of Keyway.	Shank Depth.	Taper per Foot.
	D	A	P	B	H	K	L	T	t	W	S	
1	.369	.475	2 1/8	2 9/16	2 3/16	2 1/16	3/4	5/16	13/64	.213	2 3/8	.600
2	.572	.700	2 9/16	3 1/16	2 5/8	2 1/2	7/8	3/8	1/4	.260	2 7/8	.602
3	.778	.938	3 3/16	3 3/4	3 1/4	3 1/16	1 1/16	7/16	5/16	.322	3 9/16	.602
4	1.020	1.231	4 1/16	4 7/8	4 1/8	3 7/8	1 1/4	1/2	15/32	.478	4 5/8	.623
5	1.475	1.748	5 3/16	6	5 1/4	4 15/16	1 1/2	3/4	5/8	.635	5 7/8	.630
6	2.116	2.494	7 1/4	8 5/16	7 3/8	7	1 3/4	7/8	3/4	.760	8	.626

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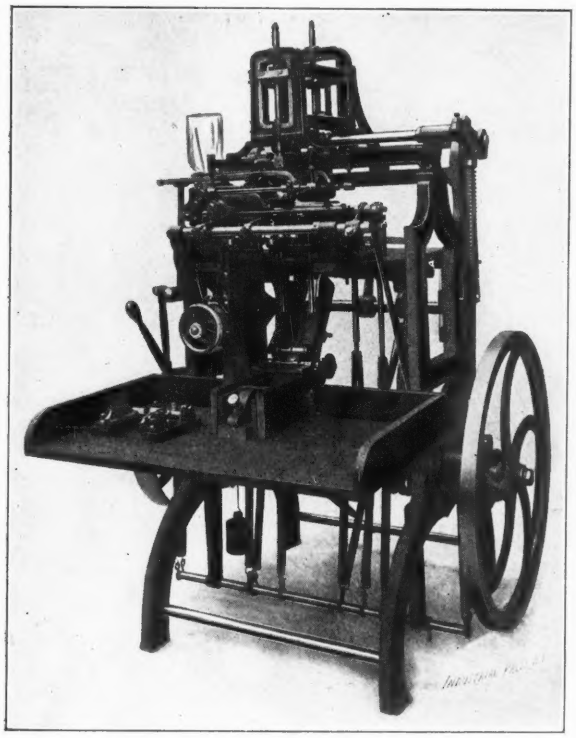
and rack. The hard steel, balanced spindle slides in cast iron sleeve which revolves in conical bearings, having lock nuts and friction washers for taking up the wear. It is driven from the slotting machine cone pulley by single and treble gear, which are placed in the spindle slide, thus giving off the power direct to the spindle. There is a clutch reverse motion for tapping and studding, with quick hand reverse for running the spindle to and from its work.

The feed motion of this tool is self-acting and variable by a three-speed cone pulley, double worm wheel and cut steel pinion and rack. There is also an instantaneous disengaging motion and hand feed. The screw keys necessary for working parts of the machine are made of mild steel case-hardened. The top driving apparatus comprises hangers, cone pulley, tight and loose pulleys, strap bar and forks. The screws and shafts are of steel and the working nuts of gun metal, while the working pins, joints, nuts and washers are case-hardened. This machine was built at the Ancoats Works of John Hetherington & Sons, Ltd., of Manchester.

* * *

AN ENVELOPE FOLDING MACHINE.

The machine illustrated below is one of a class of machines that help to turn out the enormous quantities of envelopes that are used all over this country annually. This photograph, which was obtained through the kindness of Mr. F. B. Powers, Springfield, Mass., was built for making the seed pouches that are used by the seed dealers, and is simpler and less elaborate than the machines used for producing the commercial envelope. The machine is practically automatic, but requires the services of an attendant whose duty it is to watch every motion of the machine and to supply it with



Machine for Folding Envelopes.

paper blanks and gum whenever needed. The tender also boxes the bags after they have been counted by the machine.

The paper blanks are cut out by a knife, of the proper shape, under a powerful press which produces about 500 sheets at one cutting. These blanks are placed upon an elevator table by which they are fed to the machine as they are needed. Suitably gummed pickers take the top sheet from the feed table and drop it onto the carriers which convey it to the creasing box and thence down to the folders which fold the blank on a trap door arrangement. From here the folded blank is dropped onto a conveying chain, composed of specially-shaped links which hold the envelope in proper position for the gummed flap to dry. From this chain, at a given point, the packets are dropped into the delivery box and counted in packages of the number desired, usually 25 in each package.

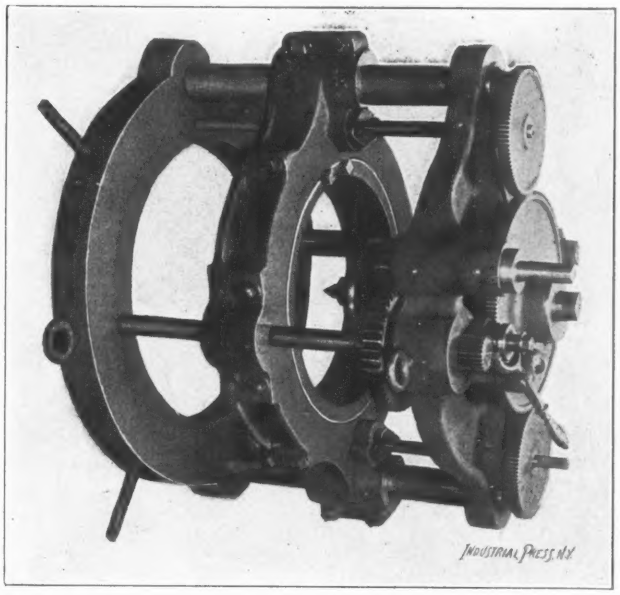
The rate of production of these machines is about 110 bags or envelopes per minute, which would amount to 66,000 per day of ten hours. In all such machines there is, however, a percentage of loss in production but 60,000 per day is usually expected when the machine is in good order.

F. W. Clough.

* * *

A CRANKPIN TURNING MACHINE.

One of the most difficult jobs in connection with steam engine repair work is that of re-turning large crankpins, since it is unpractical to remove them from the disks and the turning must be done in place. The cut illustrates a machine that is designed for this sort of work and is capable of turning a crank pin up to 15 inches in diameter and 12 inches long. The machine is placed over the pin with the center, shown at the right hand side, fitting the female center



Machine for Turning Crankpins.

in the end of the crankpin. The four radial screws at the outer end of the machine are then used to adjust it properly in line with the pin, after which it is clamped to the crank by bolts and the adjusting screws are backed off out of the way of the cutter. In some pins the outer end has a tapped hole, used for bolting on a cap, and when used with such pins the center shown in the cut is replaced by a rod and bushing which fit the tapped hole. The end of the rod projects from the center of the outer end of the machine and is clamped there by a split hub.

The cutter-head, carrying the turning tools, is held in an annular ring which revolves in a traveling head frame. On the back of the ring is cut a gear so that it may be driven by a pinion connected to the driving shaft. Upon this shaft may be mounted a pulley or grooved sheave so that the machine can be driven from any convenient belt or rope drive. Upon opposite sides of the frame that carries the cutter-head are two feed screws which are connected at the top by suitable gears meshing with the feed gears, on the driving shaft, and thus providing for automatic feed. When finishing fillets, at the top or bottom of a pin, the automatic feed may be disconnected and the head fed by means of a crank applied to the end of one of the feed screws. The machine is the product of H. B. Underwood and Co., Philadelphia, Pa.

* * *

It is estimated that 110,000,000 railroad ties were used in this country the past year. One firm has contracts for ties extending over a period of eight years and will cut timber every year off 300 square miles of land. From these figures some idea can be had of the quantity of timber used in this country for railroad ties, and also of the importance of some method both for preserving the ties against decay and preventing the rails from cutting into and destroying them.

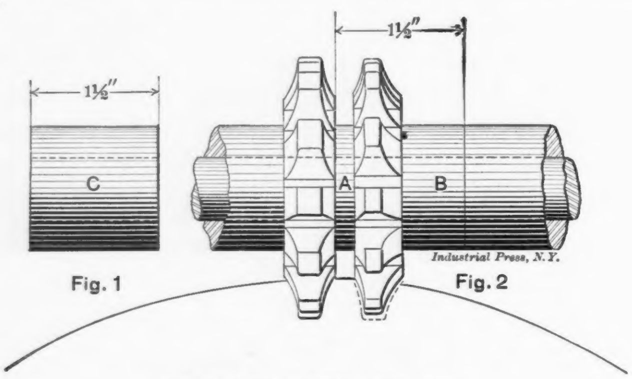
LETTERS UPON PRACTICAL SUBJECTS.

ROUGHING AND FINISHING GEARS SIMULTANEOUSLY.

Editor MACHINERY:

Having a large number of steel gears to cut on an ordinary horizontal milling machine and an accurate job being required, I decided to take both a roughing and finishing cut; as it is well known that a single cut in steel does not leave the teeth in very smooth condition. As time was an important element in the job it was arranged to take these two cuts simultaneously, thus saving the time that would be necessary to index the gears around twice.

To do this the roughing cutter was first put onto the arbor with the collar *C*, Fig. 1, on the inside. This collar was just 1½ inches wide. Then one space was cut with this cutter alone, set to cut .015 inch less than full depth of the tooth.



Roughing and Finishing Gear Teeth.

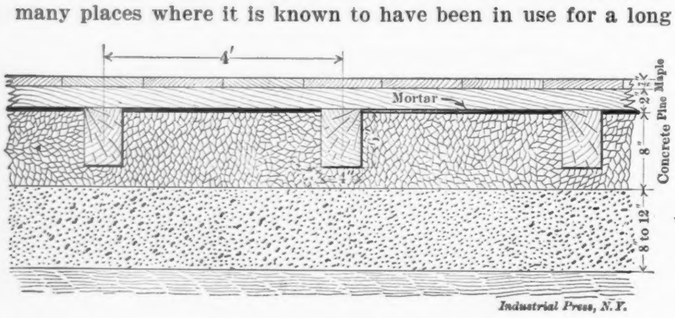
This cutter was then taken off and the 1½ inch collar removed. In its place the roughing cutter was put on with two collars *A* and *B*, whose combined thickness together with that of the cutter equalled 1½ inches. The collar *A* was of such thickness that the roughing cutter would come in the center of the tooth space, as shown by the dotted lines in Fig. 2. The finishing cutter was then put in place, the table raised .015, and the finishing cut taken through the space that had previously been roughed out. While this was being done by the finishing cutter, the roughing cutter was stocking out the next space at the right. Once started as above described, the gears were cut exactly the same as when using a single cutter and the result, in obtaining smoothly-finished gears, was most satisfactory. R. A. LACHMANN.

Chicago, Ill.

NOTES ON SHOP FLOORING.

Editor MACHINERY:

Having read with much interest Mr. Perrigo's article in the February number of MACHINERY, upon the subject of shop floors, I would call attention to a style of floor that he does not mention, but one which has proved very satisfactory in many places where it is known to have been in use for a long



Section of Shop Floor.

time. It consists of a foundation of sand or cinders to a depth of from 8 to 12 inches, depending upon the condition of the earth, which is finished off at a depth of 11 inches below the floor grade. Upon this are placed 4 x 6-inch sills or nailing strips, blocked up until level, with the under edge raised 2 inches from the sand or cinders. Between and under these sills is tamped a concrete composed of eight parts crushed stone or screened gravel, four parts sand, and one part natural (Louisville) cement. This fills as near to the top of the sills as possible but should not project above them. Upon this, after about 12 hours' drying, is spread a rather thin layer of mortar, or grout, composed of one part natural cement to two parts sand. This is struck off flush with the top of the sills, upon which the sub-floor is laid. This floor is made of 2 x 6-inch dressed and matched pine, well spiked into place before the grout has become dried. In the presence of dampness, where rotting is feared, a bed of hot tar may be placed upon the concrete before laying the sub-floor.

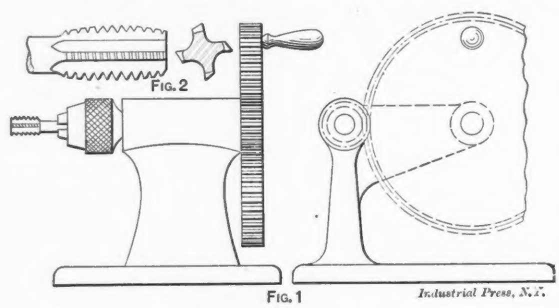
After the machinery has been placed a flooring of ⅞-inch maple, dressed and matched, 3 inches wide, is nailed diagonally on top of the sub-floor. This maple can be obtained for about $18 or $20 per thousand by taking the short lengths and pieces that are off color, but which are just as good as any for this purpose. The resulting floor is very satisfactory, being easy to truck upon and neither splintering like pine nor crushing like concrete and there is no danger from fire, as in the floor laid on joists with ventilation below. When the maple wears out it can be easily renewed, the floor is easy to keep clean, and what is of prime importance—it is cheap to construct, as the cost is about 10 cents per square foot after grading.

For a "scaffold," or cupola floor, I have found rolled steel plates with the raised diamond pattern to be very much better than the cast iron plates. These can be obtained in widths up to 40 inches and in lengths to 16 feet. Although their first cost is a little more than the cast iron plates, they are more reliable and wear much better. They should be laid and riveted to steel beams. C. J. M.

A SAFETY TAPPING ARRANGEMENT.

Editor MACHINERY:

Having tried a great many devices for tapping small holes and found that they all require more or less skill in their operation, and even with a skillful operator taps were frequently broken, I have made the little tapping machine that is shown in Fig. 1, and find it very effective. With it, it is practically impossible to break the taps no matter how small and delicate they may be, while no skill whatever is required to use it. The machine consists simply of two gears, having a ratio of about 4 or 6 to 1, according to the size of the tap. The gear is mounted on an outboard bearing and meshes with the pinion which is fastened to the end of the shaft carrying



A Safety Tapping Device.

the tap in a small chuck. A handle is fitted to the driving gear, and it has been found that the operator has not sufficient strength to break the tap by turning on the handle. If the taps used are very delicate it may be necessary to increase the gear ratio to 8 to 1, or more, but a point will soon be found where it will be impossible to break the taps. I have found this device to work very satisfactorily for tapping No. 1-60 holes in brass, which is considered an unusually severe test on a tap.

The taps, which are made as shown in Fig. 2, have a slight taper each way leaving only a short distance of their length the full size. The object of tapering the rear end is to relieve the strain on the tap and still have sufficient thread to feed it back if it is run way through the hole. In making the flutes I leave the threads quite narrow and back them off so

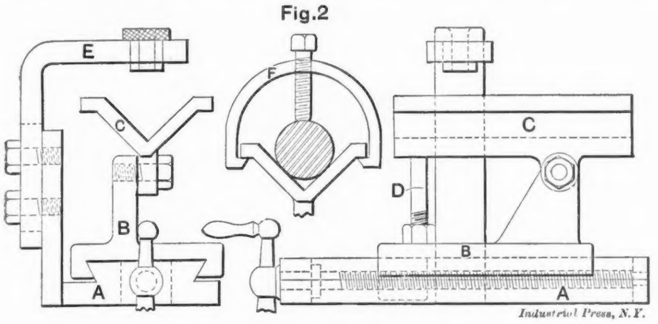
as to leave very sharp cutting edges. Of course a tap made in this way will not last as long as one made in the usual manner, but it will do much better work with less danger of breaking. F. G. DAVIDSON.

Brooklyn, N. Y.

A HANDY DRILLING FIXTURE.

Editor MACHINERY:

In a shop in which I was once employed we had in use a V-block which proved to be of the greatest convenience for drilling shafts, spindles or other round pieces. The base *A* was dovetailed and fitted with a lead screw which moved the slide *B* in and out under the drilling arm. Upon this slide was mounted the adjustable V-block *C*, which could be tipped at any desired angle for oblique drilling or set perpendicularly to hold the shafts in position for end drilling. The adjustable stud *D* was placed under the outer end of the block to hold it firmly in any set position. The drill arm *E* was adjustable up and down, for different sized shafts, and was supplied with



Adjustable Drilling Fixture.

a complete set of bushings for use with drills of different diameters. When mortising spindles for facers, boring bars, etc., the work was clamped into the V with the clamp *F*, shown in Fig. 2, then, after the first hole had been drilled, the slide was moved along for a distance equal to the diameter of the drill and the next hole drilled, and so on. By this method any number of holes could be drilled in perfect line and always through the center of the bar. By the use of a stop clamped across the end of the slide, the attachment formed a jig which could be used for a great variety of duplicate drilling. ROY W. HARRIS.

Salem, Ohio.

PUNCH AND DIE FOR PERFORMING SIX OPERATIONS SIMULTANEOUSLY.

Editor MACHINERY:

A very interesting job of punch and die work which recently came to my notice was the production of small metallic caps such as are shown at *H* in Fig. 1. These were made from brass about .032 inch in thickness and to produce a finished cap six operations were required. The punch and die by which they were made were so arranged as to perform all six operations simultaneously and thus turn out a finished cap

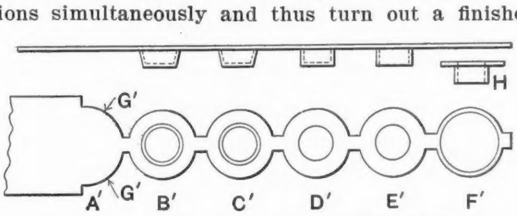


Fig. 1. The Work as Punched.

at each stroke of the press. Fig. 2 shows the combined blanking and drawing punch, the letters on each punch corresponding with the primed letters used in Fig. 1, to denote the different operations. Fig. 3 shows the die in section and plan.

The strip of stock is fed under the punches *A*, *A*, and the end of it is cut by the front end of the punches into the semi-circular form shown at *A'*, Fig. 1. For the second operation this round end of the strip is pushed ahead until the points *G'*, *G'*, come against the pins *G*, *G* (Fig. 3) which are set in the face of the die. This locates the blank in position for the first drawing which is performed by the punch *B*. At the same time that the drawing is being done, the punches *A*, *A*, are cutting the next section so that it may be gaged by the pins *G G*. To insure these punches cutting all the stock around the semi-circle, each side is extended 1-32 inch beyond the center of the circle so that the cuts overlap. All of the stock which they remove is pushed through the die and falls to the floor or into a scrap box.

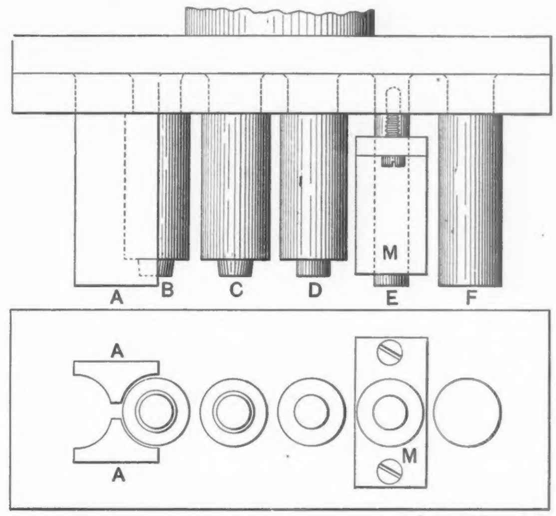


Fig. 2. Punch for six Simultaneous Operations.

The next two strokes of the press continue the drawing as shown at *C'* and *D'*, after which the cap is ready to be punched. This is done by the punch *E*, which is provided with an additional stripper *M* to prevent the punch from sticking to the cap, and raising it from the die, on the return stroke. The die *K*, is made of a hardened steel ring that is fitted snugly in its seat and is held in place by the ring

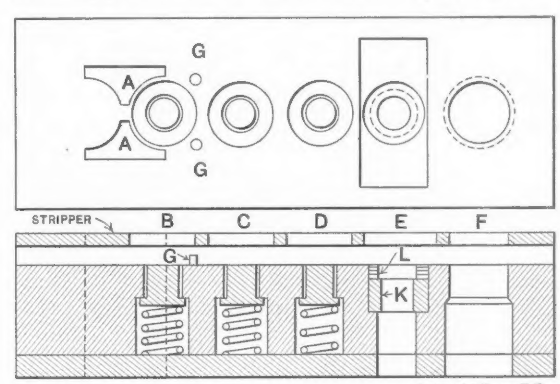


Fig. 3. Die for six Simultaneous Operations.

L; both rings being easily removed when it is necessary to grind the die. The last operation which is performed by the punch *F*, consists in cutting the now completed cap from the strip of stock. From this operation the finished cap falls, through the bottom of the die, into a box; while the refuse stock issues from the machine in a string of rings as shown at *F'*. TOOLMAKER.

WHERE SHALL THE BREAK COME?

Editor MACHINERY:

There is one point in the design of any machine tool or mechanical construction that is often, if not generally, neglected. This is the consideration of making one place or piece in the construction of much less strength than the other parts. Every machine is liable, at some time or other, to be subjected to a shock or load that is far in excess of any for which it was designed. When this occurs something will have to break and it seems that it is just as much a part of good designing to provide for this breaking point as for any other feature in the design. If, after the parts of the machine are calculated for all allowable loads, a factor of safety is added for excessive loading, one part should be given a much lower margin of safety than the others, and this part should

be one which will be the least expensive and cause the least delay in replacing. One or two cases that have lately come to the writer's notice will serve to illustrate the importance of this point in machine designing.

The first case was that of two power presses, of the beam type, both of which were broken at about the same time. The break in both cases was caused by the die slipping out of place so that the punch came down onto the hard steel surface. It could not punch this, and as the presses had powerful drives something had to break. In the first press all the castings had been made strong enough for all ordinary purposes, and in order to make the press amply strong the connection pins had been made of unnecessary size. The consequence was that when the trouble came the frame was broken and the press was ruined. In the other case the connection pins, or one of them at least, was made only strong enough to stand a very slight overload, and when the accident happened one of these pins was immediately broken. It was a matter of less than an hour's work to replace this pin and the press was just as good as new.

Another case came to notice when designing a large spur gear and pinion. The design, as first proposed, called for a cast iron gear and a steel pinion, and had the gear been designed to stand the required load the steel pinion would have been of about equal strength. In small tool designing this would have been considered very good practice but in this case it was considered advisable to reverse the arrangement somewhat. The pinion was made of cast iron and designed with a comparatively low factor of safety for the maximum load. The gear was also of cast iron but, having the same pitch and face, was consequently capable of carrying a much heavier load than the pinion. The combination as now installed provides for the worst possible accident to be the breaking of a small pinion, thereby saving the gear, which is 13 feet in diameter, and worth many times the value of the pinion. GEO. FROST.

PUNCH AND DIE FOR FORMING RING OR TUBE IN TWO OPERATIONS.

Editor MACHINERY:

The accompanying sketches show the punches and dies that are used for making rings or tubes in but two operations. In usual practice this class of work requires three operations and the saving of one of these amounts to quite an item in time and expense.

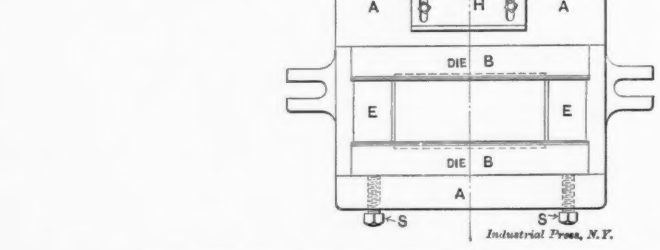


Fig. 1. First Operation for Forming the Ring.

The first operation is performed with the die shown in the cut, Fig. 1. Most diemakers insist that this die should be made out of a solid piece of steel, but I have made a number of dies in the way shown and they have all given perfect satisfaction. *A* is the cast iron holder having the opening *F*. The die consists of the pieces *BB*, which are simply two strips of steel, hardened and ground, that are kept in proper position by the cast iron spacers *EE*. Both dies and spacers are firmly clamped by two set screws *SS*. The spacers may be placed at any distance apart that the length of the die allows and thus a die can be formed for a ring ¼ inch wide or a tube 6 inches long. The action of this die will be clearly seen by reference to the cut. The stock, which is cut to length, is placed against the gage plate *H*, then the punch descends and pushes it through the die until it passes the points *GG*, which act as strippers on the return stroke.

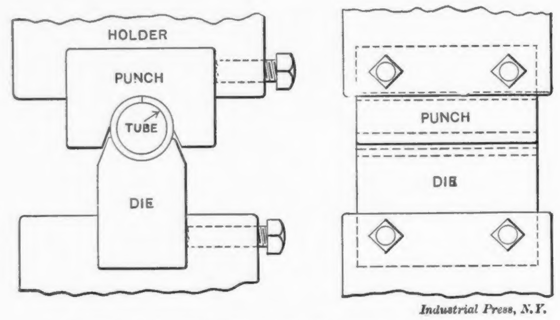


Fig. 2. Second Operation for Forming the Ring.

The second operation is accomplished with the very simple punch and die, shown in Fig. 2, which completely finishes the ring and thus dispenses with a third operation. After the blank leaves the first die it is in the shape of a U. The bottom of this is placed in the die, and as the punch descends the bevel, touching the upper edges of the U, gives them the required bend for entering the semicircle in the punch. The ring or tube is completed when the punch is at the end of the stroke. G. D.

MAKING A HOLLOW SPINDLE LATHE.

Editor MACHINERY:

Every machinist knows the advantages which the hollow spindle lathe of to-day has over the old-fashioned lathe with solid spindle. In our shop we were in need of another hollow spindle lathe for a job upon which we were working, and as we had enough of these lathes for all ordinary work, we did not want to purchase a new one especially for this job. We had a solid spindle lathe that was in every other way suited to the work, so I undertook to transform it into a hollow spindle lathe in the following manner:

I first took the spindle out of the headstock and put it into another lathe on the head center and the steady rest. A hole was drilled about half way through it, from the back end, and a thread cut for a short distance on this end. It was then replaced in the headstock on the old lathe and a hole drilled in from the front end to meet that which was drilled before. Of course the two holes did not meet exactly, so an extension boring bar was used, and the full-sized hole drilled completely through the spindle. In place of the adjusting screw, on the end of the spindle, a washer about one-half inch was bored and threaded to fit the thread that had previously been cut on the end of the spindle. Spanner holes were drilled on the periphery of this washer so that it could be screwed up for adjustment, and the lathe was ready for use. ROBERT B. OTIS.

Orange, Conn.

AN AUTOMATIC MILLING MACHINE ATTACHMENT.

Editor MACHINERY:

The accompanying cuts illustrate a milling attachment that was made for automatically milling and indexing certain pieces of work, and while it may yet be farther improved it has so far proved very satisfactory for any of the work that it has had to do. Formerly an independent fixture was required for holding each piece of work to be milled, and one man or boy was required to tend each machine. With three or four of these automatic attachments an unlimited variety of work can be accomplished, and but one workman will be required to attend to the four machines. All that is necessary is to have a set of cams for each piece of work that is to be milled on the fixture. A variety of pieces of work that can be milled in this way is shown in Fig. 1, and in the illustration of the machine it is cammed for the piece that is marked

A in this figure. This piece, which is of steel, is 1 inch long and 1⅛ inches in diameter; it has a ¾-inch hole and twenty-four 60-degree teeth. This piece formerly gave considerable trouble, when it was milled with an ordinary fixture, as the bottom of the 60-degree cut was required to be as sharp as possible. With the old fixtures the operator used often to strike the work too suddenly, when starting a new cut, and in consequence the sharp points of the cutter were broken off

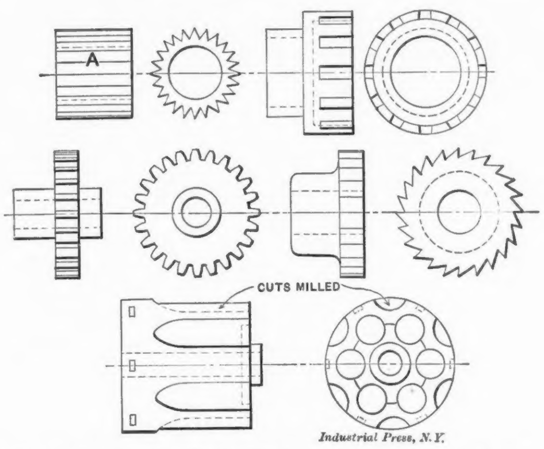
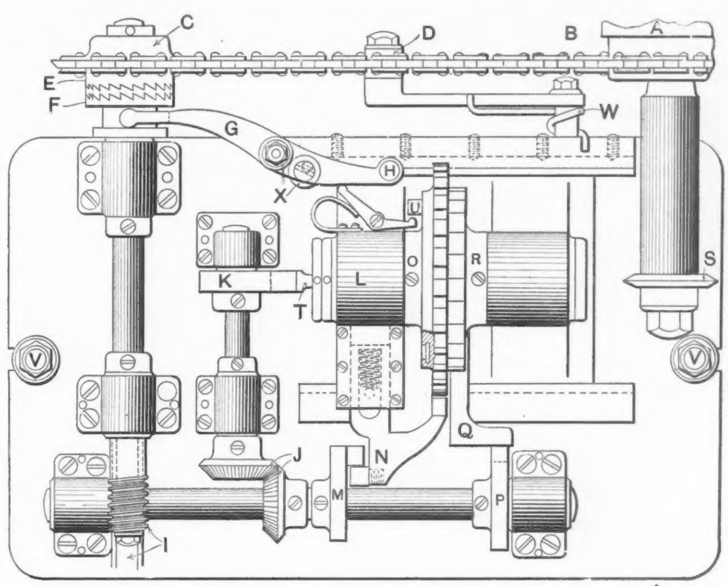


Fig. 1. Some of the Work Milled with Automatic Attachment.

and much delay caused by replacing the cutter and resetting the fixture. This led to the design of the automatic fixture and it proved so effective for this work that it was consigned to many other pieces, thus becoming a universal tool.

slack side of the chain by the spring *W*. The sprocket *C*, having on its hub the clutch *E*, runs loose on the driving shaft. The clutch *F* is a sliding fit on this shaft and has a keyway which slides on a key fixed in the shaft so that when *F* is in contact with *E* the shaft is made to rotate.

Upon the outer end of the driving shaft is the worm *I*, which drives the worm wheel of 41 teeth that is keyed to the cam-shaft. The milling machine spindle runs at 248 revolutions per minute; this speed is reduced to 124 by the sprocket ratio, and this further reduced, by the worm ratio, to a speed of about 3 revolutions per minute for the cam-shaft, a ratio



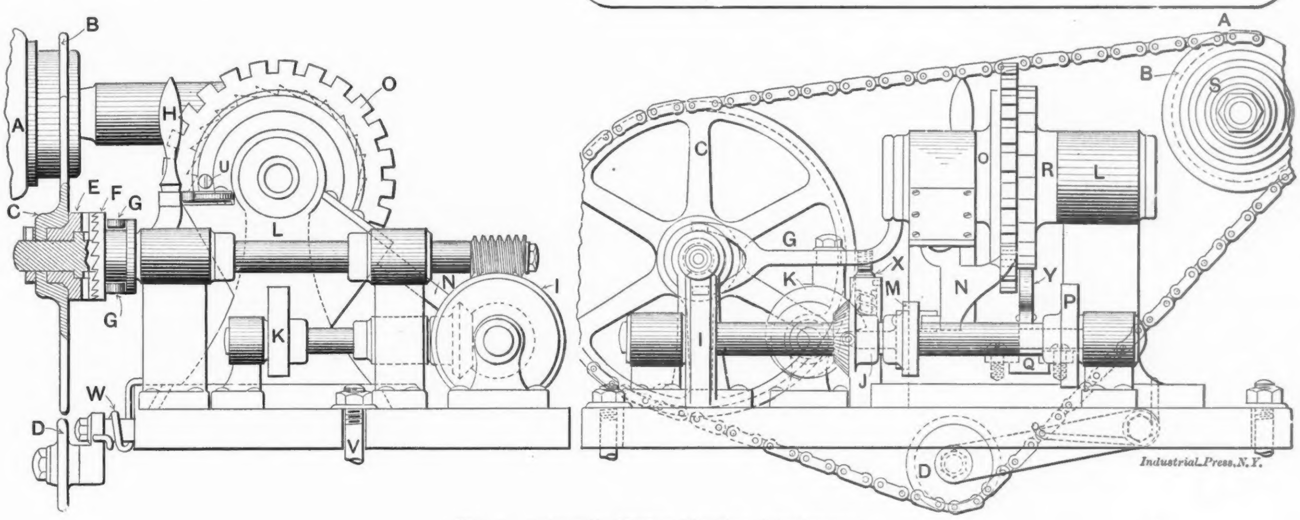


Fig. 2. Automatic Milling Machine Attachment.

The three views of the attachment, shown in Fig. 2, will serve to make plain its construction and means of operation. It is placed upon the platen of the milling machine to which it is firmly clamped by means of the two bolts *VV*. The driving mechanism consists of a ¼-inch chain running from the 12-tooth sprocket, *B*, which is screwed on the spindle of the milling machine, to the 24-tooth sprocket on the driving shaft

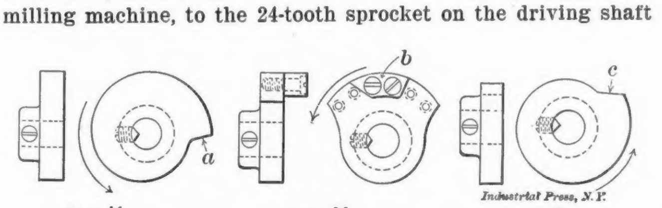


Fig. 3. Detail of the Cams.

of the fixture. As it is necessary for the operator to run the platen away from the cutter a few inches when changing his work a stop is placed on the machine so that the platen can be brought back to its proper position before the cut is started. The extra length of chain that is therefore required is kept at the proper tension by means of the 8-tooth idler *D*, mounted upon a swinging arm, which is held against the

between the milling machine spindle and the cam-shaft of about 83 to 1. In other words with the milling machine running 248 revolutions per minute a cut is made upon the work every 20 seconds. When setting the fixture for shorter cuts a larger sprocket is placed on the milling machine spindle or a smaller one on the fixture so that the speed of the cam shaft will be greater. We have 12, 14, and 16-tooth sprockets to fit the spindle and 24, 20, 16 and 12-tooth sprockets to fit the fixture, so that we can obtain satisfactory speeds for all the pieces which we have to mill.

Upon the cam-shaft will be seen a pair of miter gears *J*, which are used to drive the shaft carrying the cam *K*, at the same speed as the main cam-shaft. This cam, which is shown in detail in Fig. 3, imparts the backward-and-forward motion to the indexing head, *L*, which is dovetailed and gibbed to slide upon the base of the fixture. A spiral spring, not shown in the drawing, keeps the head always in contact with this cam. The throw of the cam is determined by the length of the slot or groove that is to be milled and the angle *a* is such that the cam finger *T* will drop back without jar and allow the head to slide back with a quick and easy motion.

Next, upon the cam shaft is the cam *M* which pulls the index finger *N* out of the index plate and holds it long enough for

the cam *P* to push the head around to the required division. The piece *b*, Fig. 3, is practically the cam and the body *M* is never taken from the shaft. For obtaining changes in the length of time that the cam holds the pin out of the plate, different pieces are fastened on in the place of the one shown. Six tapped holes are provided for this purpose so that cam pieces of almost any length may be attached.

The piece *Q* is a slide to which is fastened the pawl *Y*. This slide is held against the cam *P* by a spiral spring and the pawl engages the ratchet disk *R*, and so moves the head around for the number of teeth required. Both indexing plate *O* and ratchet *R*, have 24 teeth so that 2, 3, 4, 6, 8, 12 or 24 divisions may be obtained. The throw of the cam *P* depends upon the number of divisions that the ratchet plate is to be turned. *c*, on this cam, is a sharp slide so that the throw takes place quickly, after which the cam carries the pawl gradually back into position for the next indexing. At the end of one complete revolution of the indexing head the pin *U* strikes against a small bell crank and throws the lever so as to disengage the clutch *F*, thereby allowing the clutch *E* and the sprocket *C* to run loosely on the driving shaft until the machine is again started by throwing the lever back so as to re-engage the driving clutch. A quick movement is given to this lever by means of a spiral spring under the stud *X*, as will be seen in the front view in Fig. 2. At its top this stud is beveled off on two sides, so as to make a point of about 90 degrees and this bears against a similar stud screwed into the under side of the lever. Besides imparting a quick motion to the lever, these studs tend to keep the clutches in or out of engagement. The stop *U* can be adjusted to any point as it is held in a circular T slot which extends completely around the plate.

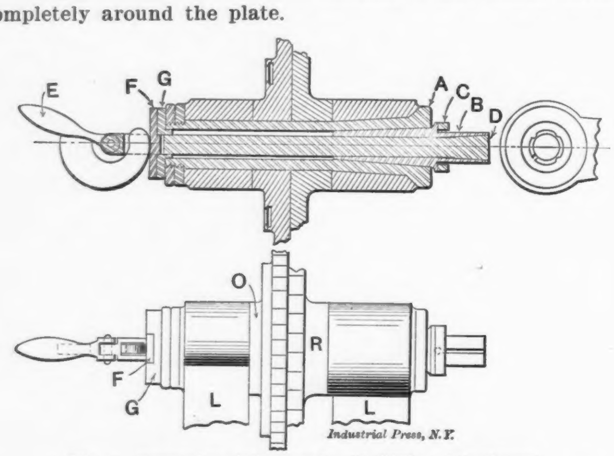


Fig. 4. Expansion Arbor used with Milling Attachment.

Each set of cams is marked for the particular piece for which they are adapted; on cam *K* is also marked the number of teeth in the sprockets that are to be used on both the milling spindle and the driving shaft of the fixture; while on the cam *P* is marked the depth of the cut that is to be milled in the work. A special arbor to hold the milling cutters is made for each job and the cutter is located on the arbor at a certain distance from the sprocket on the spindle so that by centering the fixture with the cutter the sprockets will come in line.

The work is held on a quick-acting expansion arbor which is shown in detail in Fig. 4. The piece to be milled is placed upon the split bushing *B* which is tightened in the hole by a movement of the lever *E*, that pulls back the spindle *D* and expands the bushing. A collar *C* is fastened to the chuck so that the slots in the bushing can be run beyond the shoulder against which the work bears, and a more effective expansion is thus secured. This fixture may be used on any style of milling machine and should there be no thread on the spindle to receive the sprocket *B*, it may be placed on the arbor as near to the spindle as convenient. Jos. M. Stabel.

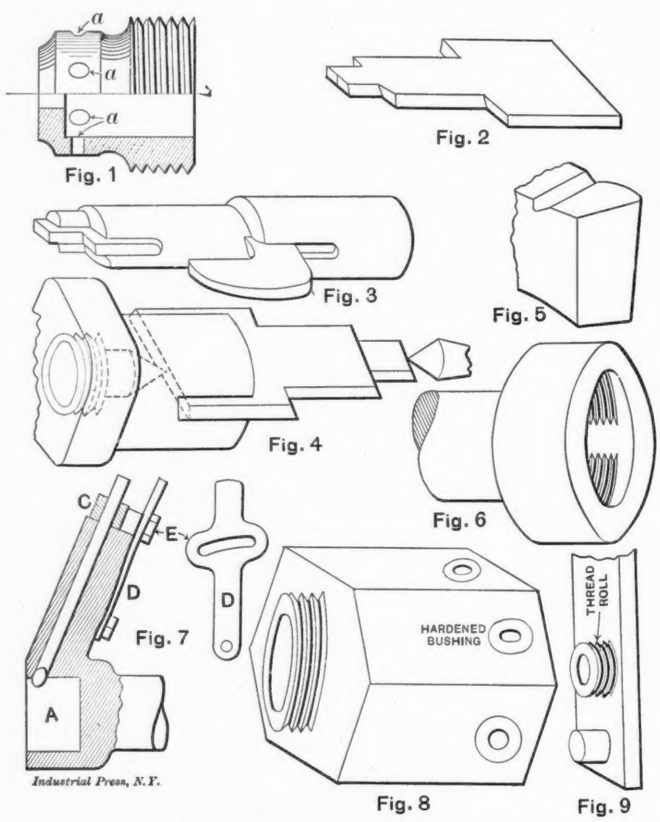
New Haven, Conn.

TOOLS FOR A BRASS PACKING GLAND.

Editor Machinery:

The tool maker had just been confronted with a new problem. A design called for a large number of pieces as shown in Fig. 1, and he was to make all necessary tools and the jig for drilling the holes *a, a, a*. The inside was plain, but as a good job was necessary, both a roughing and finishing tool were provided. The roughing tool was made from flat steel as shown at Fig. 2. The finishing tool, which is shown in Fig. 3, was provided with a milling wing for turning the body ready to thread, and this turning took place simultaneously with the finish boring.

For those who are not familiar with flat cutters, it may be said that they are cheap, very efficient for roughing and, when thick enough, make good finishing tools. As may be imagined they are not very easy things to turn in a lathe, but the use of the little driving chuck shown in Fig. 4 makes it much easier. This chuck screws onto the spindle, in the usual manner, and when turning a flat cutter, it is simply centered like a round piece and put into the slot in the chuck and between the centers as shown in the cut. Do not expect a diamond-pointed tool to stand this kind of work, however, or you will be disappointed. Use a round-nose side tool for roughing, and then for finishing, the *side* of a diamond-pointed tool may be used, although a tool something like that shown in Fig. 5 will be found very satisfactory. This sort of work is very hard on a lathe as there is a shock, equivalent to an upward blow on the centers, twice to each revolution.



Tools for Machining a Brass Packing Gland.

The milling cutter being on the finishing bar insures the outside being true with the inside, and it should be fed very slowly into the work. For very exact work, it would probably have been better to have used two bars with a wing milling cutter on each, instead of roughing with a flat cutter, but in this case the flat cutter was all right. To make sure that the work entered the die truly, the thread was cut away from the mouth as shown in Fig. 6. This could not be done in all cases, but worked very well in this one as there was plenty of room.

These tools completed the first operation, and the threaded end was then held in a screw chuck while the other end was being finished. This was accomplished by using a wing milling tool, similar to that used for the other end, with a plain bar that entered the hole before the cutter began to work. This gave a guide for the milling tool, held it to its work and left the piece ready for necking with the tool shown in Fig. 7. This tool was bored out at *A* to fit the finished end of the gland while a piece of 3/8-inch drill rod, sliding through a hole in the oblique arm, was ground at its lower end to cut the neck to its proper shape. The clamp *C* was fastened to the

rod while one side had a flange into which was set the bolt *E* that worked in an eccentric slot in the lever *D*, fastened onto the back of the oblique arm. When the lever was in its uppermost position the tool was slipped over the end of the gland and a pull on the lever then forced the cutting rod down and formed the groove.

The jig for drilling the holes was a simple affair, which is shown in Fig. 8 with one of the pieces in position. It was found that the burr raised by the drill made it almost impossible to get the piece out after it had been drilled, as there was nothing but the threaded end to get hold of. After a little thought the wrench shown in Fig. 9 was made. It consisted of a flat piece of steel with a short pin in the end. At the proper distance from this was a soft steel roll cut with a thread like that on the work and loose enough to turn freely. All that was necessary was to slip this over the end of the work, swing it into the thread and it formed a powerful lever with which the work could be easily removed.

While it is not likely that any one who reads this will have a job exactly like it, yet there are several points that can be adapted in many places. FRED H. COLVIN.

New York, N. Y.

HIGH-SPEED HELICAL GEARS.

Editor MACHINERY:

The matter of high-speed gearing has occupied the attention of the best engineers for a number of years. More or less success has been obtained in this line by the substitution of a softer material in place of the metal generally used, such as leather, fiber, and rawhide. When the power transmitted is very light, this form will often prove satisfactory. The principal trouble with this soft material is the lack of proper tensile strength when subjected to heavy strain or sudden shocks. This is partially overcome by increasing the face of the material from 33 to 50 per cent. over what would be used for gears made of cast iron, but this is not always admissible. There are also many other reasons why this material is objectionable. It is usually affected greatly by the weather and temperature, which increase or decrease the diameter very noticeably and also warp the gear blank out of its true form. In addition to this, when it is necessary to use small pinions, the stock between the bottom of the cuts and the hole is not sufficient for ordinary duty. The cost of making gears of this material is considerably more for material and labor than for ordinary metal gears.

The use of metal gears with helical form of teeth is now commanding a great deal of attention, and, in many cases, they have proved to be eminently successful. For shafts running at right angles and not in the same plane, the ordinary form of "spiral gears" is illustrated by Fig. 1. This represents a pair of spiral gears with speed reduction of about 3 to 2, teeth cut left hand, 45 degree angle. Inasmuch as spiral gears are, in reality, a special form of worm and worm gears, with many threads in the worm, it is obvious that the driver or worm can be most any convenient size without changing the speed reduction. This peculiarity proves to be a great advantage in designing machines where the economy of space is an object, and this form of gear is used to considerable extent in many of the latest machines. This style, with shafts at right angles, creates more friction than the ordinary form of gears; consequently it should be used only for ordinary speeds and power, and is generally provided with good thrust bearings to take up the end strain on the shafts, thereby reducing the friction on the gear.

If this special gear is properly designed, and made by one experienced in this line of gears, very wonderful results can be obtained and will establish the fact that its use is almost unlimited. This is verified by the use of same in most all up-to-date machines. Modern gear machine manufacturers use it almost wholly for the cutter drive. It is also used quite extensively in automatic machines, drill presses, etc. For heavy work, the gears should be run in a bath of heavy cylinder oil. For high speed and light power they are also used extensively for the best form of blacksmiths' blowers, such as the Champion blower, and are also used by the best makers of centrifugal cream separators, such as are made by the Burrell Mfg. Co. A speed of 10,000 to 20,000 revolutions is maintained with best results, making little or no noise and exhibiting wonderful durability. We believe this form of gearing can be run at as high a speed as 30,000 revolutions, if properly constructed.

For parallel shafts, a form of double helical spur gear is represented by Fig. 2. These are generally called "herringbone" gears. The single form, usually called "helical spurs," is illustrated by Fig. 3. Formerly, this style of gear was cut with the teeth at an angle of 45 degrees, but this is found to be unnecessary, as much better results are obtained with teeth cut on an average of from 10 to 20 degree angle. The cuts represent teeth cut on an angle of about 15 degrees. The correct angle is determined by the face and pitch. All that is necessary is that the angle be sufficient so that the tooth at one side is opposite the adjacent space at the other side of the face of the gear, or, if anything, a trifle more angle is preferred. Too much angle causes unnecessary thrust which would be particularly noticeable in the single form. (Fig. 3.) There is also less contact of tooth where the angle is great than where small, as the tooth contact at 45 degree angle or more will be that of a point only, whereas the contact at a smaller angle approaches that of a line, as in ordinary spur gears, thus giving a greater bearing surface for strength and durability.

In most cases the single form will prove quite satisfactory. For severe duty and very high speed the best results, however, are obtained by the use of the double or herringbone form of gear, as there is no end thrust on the shafts because one set counterbalances the other. The gears, when placed together, should have the teeth staggered, so that the teeth of one set of gears are opposite the spaces of the adjacent gears. Placed in this way, we gain the same advantage, while using a coarser pitch for strength, as if the teeth were cut much finer, as there will be more teeth in mesh at a time than if teeth were placed opposite teeth. This will be particularly advantageous where there is a small number of teeth in the pinion. The edges of the teeth, where the two halves touch, should be turned off slightly to avoid interference at the corners. (See Fig. 2.)

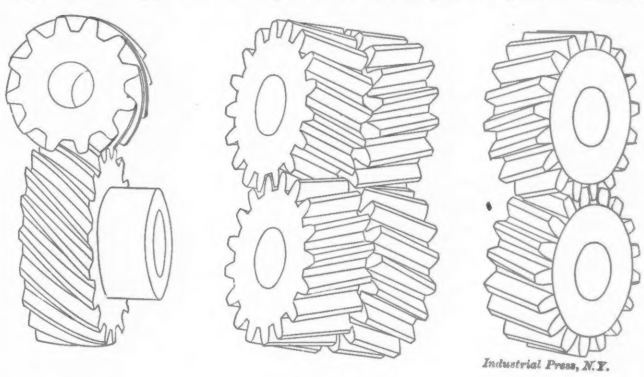


Fig. 1. Fig. 2. Fig. 3.
High-speed Helical Gears.

Unless the gears are cut very accurately, this helical form will be of no special advantage over the ordinary spur gear style. Ordinary milling machine heads, with index of 3 to 4 inches diameter, will usually not be accurate enough for spacing this style of gearing, as the object to be gained—that is, silent running gears—will be defeated unless the spacing is exceptionally accurate. Special machinery for cutting with great accuracy of spacing is absolutely necessary for best results. Selecting or designing cutters for this purpose, of correct curve or pitch, also requires unusual care. Under proper conditions of cutting and mounting gears of this style, they can be very often run at a speed of from 1,500 to 3,000 revolutions, with very little or no noise. We believe it safe to predict that inside of ten years, all up-to-date machines will be made with spur gears of helical form of tooth. In lathes, milling machines and other tools they will have the great advantage of not only running smoothly and quietly, but will permit better approach of tools to the work than would be the case if ordinary clattering spur gears were used. The worm gear drive of the Sellers planer and of other

makers has already proved the desirability of such a drive over the ordinary spur gear.

The French people hold the honor of the greatest advance in this line, in using bevel gears with curved teeth in place of the ordinary straight planed teeth, and there is no doubt, after the helical spur gear style has been thoroughly adopted, that the bevel gear will follow in line. FRANK BURGESS.

Boston, Mass.

BRASS WORKING TOOLS.

Editor MACHINERY:

When a little brass work is to be done in the average machine shop, it is naturally handled in the same manner as iron. The result is not always satisfactory either to the workman or to the employer when he comes to pay the bill, and the mode of procedure would make a Fox lathe-man have heart failure. Anything between the various mixtures of lead, tin, copper and other metals and the old "six of copper, one of tin" alloy is called brass, but that usually found contains just as little copper and tin as possible, as they are the costly ingredients. Pure copper is not a nice metal to turn, as it comes off in shavings more like wrought iron than any of the softer mixtures. These fly off in chips, which seem red hot when they strike the arm or the face.

Brass work is generally held in a two, three or four jaw chuck, or on a screw chuck which holds one end of the piece that has been previously threaded for it. It is seldom held between centers, so that the back head or tailstock is left free, and in the Fox lathes this is provided with a cross feed movement similar to the cross feed on the tool post of an engine lathe. This and the movement of the spindle give the operator a wide field of operation when carrying the proper tools in the tailstock.

Beginning with hand work we have an array of tools like those shown in Fig. 1. For roughing out work or getting under the scale of the casting a small round-nose tool like No. 5 is generally used, while Nos. 3 and 4 are for finishing in round corners or roughing concave surfaces. After roughing, the flat portions are smoothed down with flat tools or planishers whose width and shape depend on the idea of the workman. These are also used in making any convex surface.

Cutting off is done with a tool like No. 6, which is often called a parting tool. None of these tools have any top rake, as with iron and steel tools, but are often ground off the other

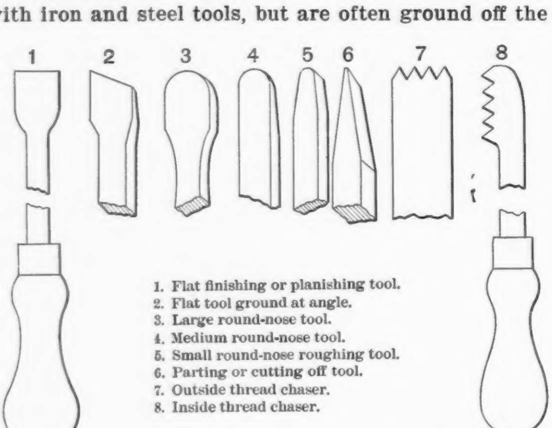


Fig. 1. Brass Working Hand Tools.

way. When carefully ground and whetted on an oil stone they will do lots of hard work, and do it smoothly. Roughing tools need not be whetted, but may be used as ground. Chasers are shown by Nos. 7 and 8, which are respectively for outside and inside work. It is quite a trick to start a true thread with these tools, but the easiest thing in the world to make a "drunken" thread, or one which does not follow a true incline, having one or more sudden jumps in it. Comparatively few men nowadays have occasion to chase a thread, or could do it without numerous failures, but for repair work or cleaning up threads these chasers are very handy.

As most of the work of this class is done on the engine or Fox lathe, the tools used will be considered. The back head uses a hook tool, similar to Nos. 9, 10 and 11, which closely resemble regular inside tools, except that the point is turned the other way for outside work. Sometimes a tool holder, as shown by No. 11, is used with small inserted tools. Slide rests are to the Fox lathe what the tool carriage is to the engine lathe and the tools are similar in form except as to size and the shape of the cutting edges. There must be no top rake or the tool will dig in badly, it being remembered that the work is held in a chuck with the outer end unsupported. By giving the tool no top rake, or even grinding down a little, all difficulty of this kind is avoided and the tool cuts just as well, to all appearances.

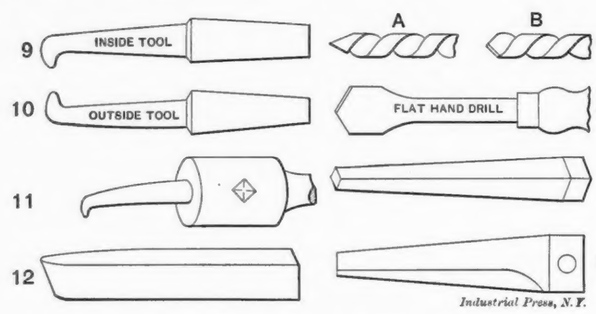


Fig. 2. Brass Working Machine Tools.

Drills, also, require special treatment if trouble is to be avoided. The twist drill as it comes from the factory or as it is used in iron is very apt to "draw into" a hole in brass or to pull through if it breaks through a piece of work. This is due to the lead on the lips. By grinding this off a little, as indicated at *B*, No. 13, Fig. 2, this trouble is avoided. On small drills it is sometimes found best to grind the whole point flat, as shown at *A* in the same figure.

For rough boring tools in a solid piece, such as an injector tube, most workmen prefer a flat hand drill, as shown by No. 14. A series of these are used for taper holes, the larger being used first and the others following to the proper depth to make about the required taper. This is then reamed out to the exact taper with various tools. A flat reamer is often employed with good results, especially for roughing. For finishing it is very apt to chatter unless packed on each side with a piece of hard wood of about the right shape to conform to the hole. Sometimes a reamer with a single large flute, as shown at No. 16, is used with good results. It is relieved nearly all the way around. For finishing, it is hard to beat the old square reamer, as shown at No. 15. This reams a nice smooth hole as it fills up with chips enough to prevent chattering, and it starts well if carefully ground and honed on an oil stone.

In this connection it may not be amiss to call attention to the too frequent misuse of the oil stone on tools of all kinds. I have seen men spend much time in carefully grinding a tool and then spoil it with an oil stone, literally destroying the edge they had obtained by grinding. Others laugh at stoning as a waste of time, but I do not agree with them, provided the stoning is properly done. Grinding trues up the cutting edge and makes it sharp, but it also throws up a rough wire edge, which does not produce good work. The oil stone, carefully applied, will remove this wire edge and not destroy the cutting edge; in fact it makes it sharper for clean cutting by removing the rough portions which are in the way.

BRASSWORKER.

FOREIGN COMPETITION.

Editor MACHINERY:

Of late we have heard a great deal about the foreign machinery market. In my observation of machinery trade in Europe I have noticed that machinery of nearly every description is higher in price than in the United States, and at present the Yankees need be afraid of no intrusion on their markets of foreign machinery.

The price of good malleable iron and steel is higher here than in the States, and although labor is cheaper, the workmen are not as efficient. It is my opinion that a better quality of work for the same price can be produced in the States. Throughout Europe good material for manufacturing is higher, and manufacturers, as a rule, make too many kinds

of machines to obtain efficiency in any particular branch. Take for instance farm implements. Every manufacturer of any note tries to make all kinds of machinery belonging to that line; harrows, rakes, plows, etc., are also made by country blacksmiths. At a fair last summer I saw a great many imitations of American rakes, reapers and mowers, but they were poor imitations, indeed. The cause of this was unskilled workmanship. The manufacture of farm implements here now is about the same as it was thirty years ago in the States. They are just beginning to use special jigs and fixtures. As a rule their products on the interchangeable plan do not fit as well as ours. I know of one large factory here that cannot supply extras without having the worn-out part so as to be sure of the kind, style and size wanted. They seem to manufacture without any regular system. Not until the European manufacturers use the same methods, or those as good, as the Americans, can they compete with them in trade. As a rule the Yankee manufacturer uses machinery and special jigs and fixtures to accomplish his work to a far greater extent than any of his competitors. In this country there is much hand-labor employed. The American has made rapid production and duplicate parts a study. He has gone at it in a businesslike manner to systematize his tools and equipments. The reason of this is the sharp competition at home and a fight for supremacy abroad. Although the manufacturer may have studied his business, and knows it well, he could not have achieved such a high standard in the business world were it not that men employed read more, study more and work harder than their foreign brothers. The American workman generally takes one or more papers pertaining to his trade, but owing to the low wages and the comparative high price of such papers the German workman cannot afford this luxury; furthermore, they are not published so that men with an ordinary education can read and understand them. This is another drawback to the manufacturer. It is the systematic co-operation between manufacturers and workmen that has helped to bring America into the foremost rank of the nations, and this is what Germany and other European nations need. Were German manufacturing systems as well organized as their military system then might America have greater cause to fear this foreign competitor. A. J. Dinkel.

Neubrandenburg, Germany.

* * *

The *Engineering News* in an editorial on dynamite and the dangers attendant to its use, points out that by far the greater number of accidents occuring in the use of this highly dangerous explosive, are caused by freezing and subsequent thawing. There are now a number of safety powders of high power on the market which do not freeze and which cannot be detonated by mechanical shock. These safety powders now cost no more than dynamite, are of practically equal power and do not deteriorate with age, or at least not so quickly as dynamite. The disastrous accidents that have occurred on the railroads have led the D. L. & W. and N. Y., N. H. & H. railroads to refuse to carry it as freight, and should other roads also put a ban on it, as they probably will, the time is not far distant when dynamite will be unobtainable except in the immediate vicinity of the factories. In view of these conditions the indications are that the use of dynamite will eventually be abandoned. Let us hope so.

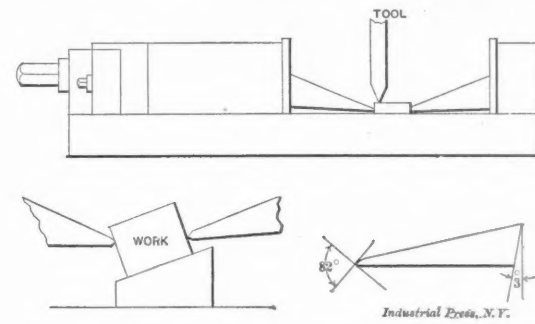
* * *

On the roof of the Western Union Telegraph building in lower New York, there is a steel tower 105 feet high which carries at the top a pole down which a time ball drops 25 feet at exactly 12 o'clock, noon, every day. The ball, according to the *Electrical Review*, consists of a framework of brass rods bent into spherical shape and covered with stout canvas. The ball is dropped by an electrical impulse sent from Washington and the instant the ball reaches the base of the pole the fact is automatically communicated back to Washington through an electric tell-tale. The noon signal is transmitted from New York by a bank of relays to 142 circuits connecting all the principal cities and towns throughout the country. In New York City alone 1,450 clocks are synchronized from the Western Union office and 150 in Brooklyn.

CONTRIBUTED NOTES AND SHOP KINKS.

CLAMPING STRIPS FOR SHAPER VISES.

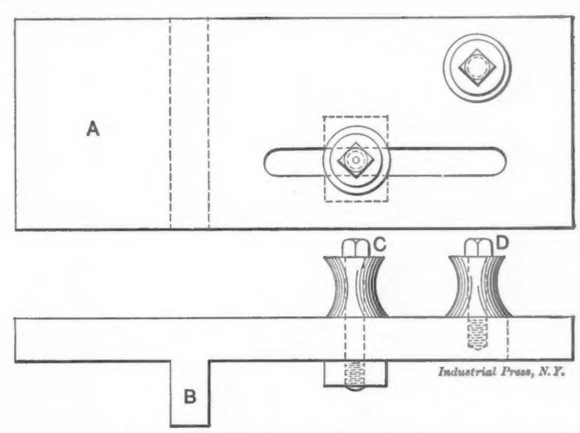
"Shaper" sends a sketch of an improved form of clamping strip for use in holding work in the shaper vise. When the vise jaws clamp the strips, the bases, which make an angle of about 3 degrees with the lower sides, naturally adjust themselves to a position parallel to the vise jaws and cause



the points, which are about 1-16 inch wide and pointed to 82 degrees, to bite in and press downward on the work, thus holding it true to the bottom of the vise or to any beveled parallel, or other piece, that may be placed under it. These strips should be of steel, hardened and ground.

A PIPE BENDING RIG.

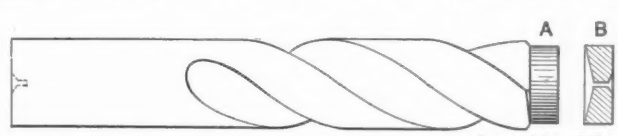
Geo. I. Babcock, Providence, R. I., sends a "kink" for a pipe-bending rig that is shown in the sketch. The plate *A* has on its under side a rib *B*, by means of which it is held in a vise when in use. This plate is fitted with two cast iron rolls, *C* and *D*, around which the pipe is bent. *D* is permanently



fixed in place but the stud by which *C* is fastened slides in a slot in the plate and can be adjusted to suit the size of pipe and the radius to which it is being bent. By placing marks on the plate any number of plates can be bent to the same curves.

GRINDING A TWIST DRILL.

It very often happens that, for some reason or other, a twist drill has to be reduced in diameter on the grinder, and as there is no center hole in the end, this is a rather difficult job. Charles P. Thiel, Lawrence, Mass., sends a description of his method of doing this, which is inexpensive and, he says, capable of producing a very good job. The "kink" consists in soldering onto the end of the drill a small brass disk,

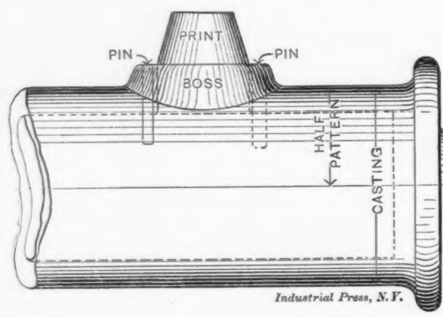


as shown at *A* in the sketch. A section through this disk is shown at *B*. He first takes a bar of brass, slightly less in diameter than that of the drill to be reduced, and in the end drills a small hole. Then the drill that is to be ground is started into the same end of the bar sufficiently deep to cut a seat that exactly fits the point of the drill. The end of the

bar is now cut off and the disk is ready for soldering. There is no danger of drawing the temper of the drill if care is taken in doing this. To do it properly a soft solder should be used and the point of the drill tinned with the soldering iron. The small hole in the disk is then plugged up with wood and the cup-shaped depression filled with solder. The drill is placed into this and held there just long enough for the solder to set sufficiently to allow the drill to be lifted up and both drill and disk plunged into water. The drill is then trued up by scraping the center.

LOOSE BOSSES ON A PATTERN.

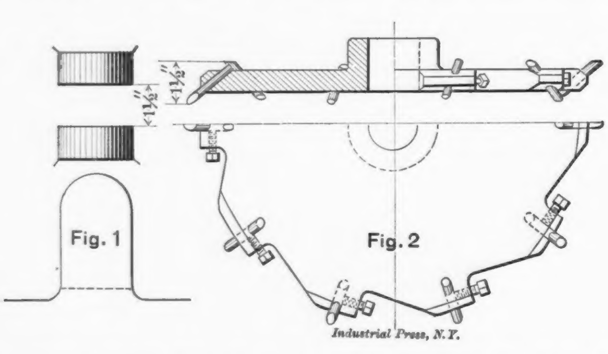
R. sends in the following kink: The sketch shows a small pattern which was to be made on a molding machine. The size and shape "cut no figure;" what I want to speak of is the boss shown in the sketch. A one-half pattern was used and the boss cast on one side only. After one half was made with the boss on, the boss was taken off and the other half made. In putting the boss on, the patternmaker did so with small



wire pins so that it would lift off in the mold. The foreman saw this and told the patternmaker to make dowel pins just tight enough so that boss would remain on the pattern after the mold was lifted off. The reason for this was: It was much easier to pick the boss off the pattern than to pick it out of the mold and in a short time destroy the boss with a lifting pin.

A SPECIAL INSERTED TOOTH MILLING CUTTER.

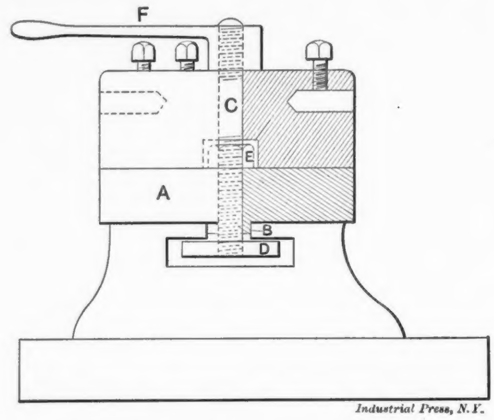
Erine Falkenrath, Racine, Wis., sends the sketch of an inserted tooth milling cutter of simple construction that was found very efficient for a job which could not be done on the planer. On the piece to be machined were a number of tall lugs (Fig. 1) which were to be finished on the inside, 1½ inches from side to side. A jig was made for holding the pieces on the vertical miller and the lugs were machined with



the cutter shown in Fig. 2. The body of this cutter was of cast iron and the teeth of Stubs steel held in place by means of set screws. The peculiar feature about the cutter was the arrangement of the teeth which were placed alternately, right and left, so as to form a two-sided cutter with which the slots were milled to an accurate width.

A TOOL POST TURRET.

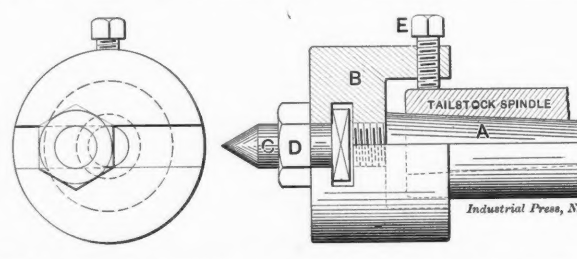
Robert B. Westover, Amherst, N. S., sends the sketch of a tool post turret which is easily constructed and in many cases, on small work, answers every purpose of a regular turret. The base *A*, which is of the same diameter as the turret head, has on its lower side a tongue *B*, which fits into the T slot of the tool post and prevents the turret from turning on the post. Through the center of the base passes the stud *C* having a square head plate *D* and the binding nut *E*. When this nut is screwed down the plate is firmly fastened to the tool post. The turret head revolves around the stud *C*, and is counterbored on the bottom to clear the binding nut. The



turret is made of cast iron and is provided with six or more holes for the tools which are held in place by means of set screws. The indexing is done by hand and the head clamped by the lever nut *F*.

AN OFF-SET CENTER.

When one has a sharp taper to turn it frequently happens that the tailstock cannot be off-set sufficiently, or the tailstock of any lathe available may not be arranged to set over at all. In such a case the off-set center, a sketch of which, sent by M. H. Westbrook, Stratford, Ont., and shown below, may be used very satisfactorily. This center consists of the



shank A, which replaces the regular dead center in the tailstock. Onto this is screwed the sleeve, *B*, which has a T-slot extending across its face. The adjustable center *C* can be set at any point in this slot and is held in place by the clamp nut, *D*. The set screw *E*, clamps the tailstock sleeve and thus prevents the arrangement from turning.

* * *

To successfully coat with tin, the castings must be absolutely clean and free from sand and oxide. They are usually freed from imbedded sand in a rattler or tumbling box, which also tends to close the surface grain and give the articles a smooth metallic face. The articles are then placed in a hot pickle of 1 part of hydrochloric acid to 4 parts of water, in which they are allowed to remain from one to two hours, or until the recesses are free from scale and sand. Spots may be removed by a scraper or wire brush. The castings are then washed in hot water and kept in clean hot water until ready to dip. For a flux, dip in a mixture composed of 4 parts of a saturated solution of sal ammoniac in water and 1 part hydrochloric acid, hot. Then dry the castings and dip them in the tin pot. The tin should be hot enough to quickly bring the castings to its own temperature when perfectly fluid, but not hot enough to quickly oxidize the surface of the tin. A sprinkling of pulverized sal ammoniac may be made on the surface of the tin or a little tallow or palm oil may be used to clear the surface and make the tinned work come out clear. Some operators again dip in a pot of hot palm oil or tallow at a temperature above that of the melted tin, for the purpose of draining the excess of tin and imparting a smooth, bright surface to the castings. As soon as the tin on the castings has chilled or set they should be washed in hot sal soda water and dried in sawdust.—*Metal Worker.*

SYSTEM OF CHUCKING CAR WHEELS FOR TURNING THE TIRES.

We have received from the Ateliers Demoor of Brussels, Belgium, matter descriptive of the L. Tricot system of chucking car wheels in lathes for turning the tires when the wheels are mounted on their axles. This system, which is also applicable to axles having outside cranks, is doubtless novel to those who are only familiar with the practice followed in American railway shops, and as it seems to possess features of considerable merit, it is briefly outlined in the following:

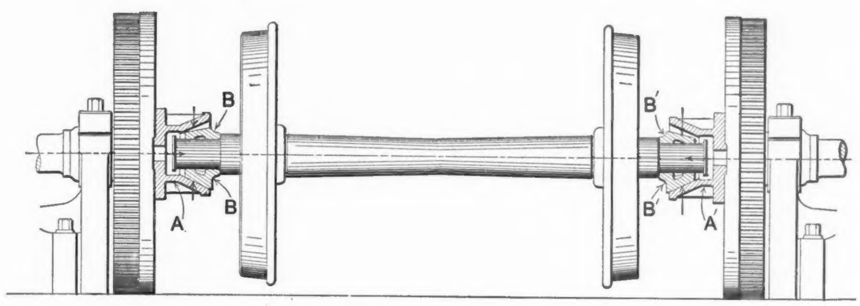


Fig. 1.

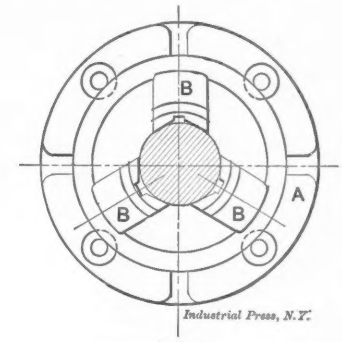


Fig. 2.

We will preface the description by remarking that in turning steel-tired car wheels mounted on their axles, one of the chief factors contributing to lack of rigidity of the work, which is so necessary to the maximum output, is the pointed poppets or centers on which the axles are "centered" in ordinary practice. These are unavoidably of comparatively weak construction and have a limited area of contact in the ends of the axles. The point of support is also some distance removed from the plane of the wheel so that the pressure of the cutting tool has a bending moment. Another fault inseparable from the system of turning tires with the axles suspended on centers, is that if the conical holes reamed in the ends of the axles are not perfectly concentric with the axle bearings, there will be a lack of truth in the turned wheels, that is, the tire periphery will be "out" with bearing surfaces. Of course when the axles are new, this defect cannot exist to any extent, but it may be present to a serious degree after an axle has been in use for some time without the bearings having been turned. Absolute concentricity of the tires and bearings is very necessary in high-speed trains. A representative of the firm has calculated that for a speed of 72 kilometers (45 miles per hour) the centrifugal force tending to produce a hammer-blow effect on the track, is 146 kilograms (321 pounds) for a pair of wheels one meter (39.37 inches) diameter, weighing 990 kilograms (1,980 pounds), and having an eccentricity of only one millimeter (.03937 inch).

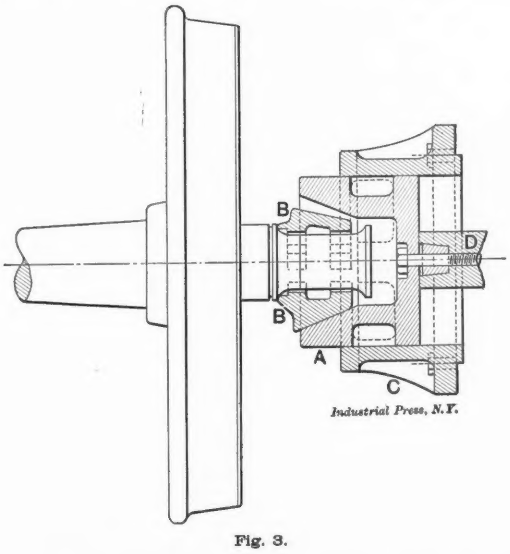


Fig. 3.

In the Ateliers-Demoor system the axles are gripped circumferentially on the bearings themselves by three jaws held in conical-mouthed chucks and pressed against the axle bearings by the resultant of the end pressure. This is illustrated in Fig. 1; and Fig. 2, of the same cut, shows an enlarged end view of one of the chucks. *A* is the chuck body and *B B B* are the three jaws. In this case, apparently, no provision is made for conveniently getting the wheels in and out of the lathe, it being necessary to move one of the headstocks a sufficient distance to clear. In Fig. 3, however, the way this difficulty may be obviated, is shown. A heavy piece *C* is bolted to the faceplate and bored cylindrically for the chuck-body *A*, which is adjustable longitudinally by means of the spindle *D*. The piece *C* solidly supports the chuck and at the same time affords clearance between the faceplates for the entering and removing of the wheels. Fig. 4 shows a special chuck employed for holding cranked axles. The construction of this form and its application, are evident from the cut.

The conical hole in the chucks made for this system, is bored to an angle of 22 degrees with the axis, making the included angle 44 degrees. The jaws are cut interiorly in open V-shape, the angle being 128 degrees. The jaws are, of course, made parallel with the axis on their inner faces so

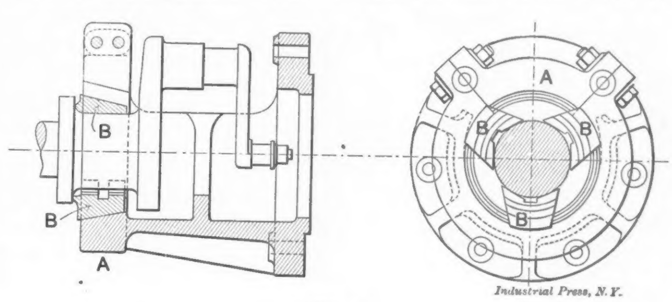


Fig. 4.

as to grip the bearing along their full length. The faces of the jaws being cut V-shape, grip the bearings at six points in its circumference so that there is little tendency to mar the surface. To entirely overcome any possibility of such action the bearings may be incased with strong paper or better, a thickness of sheet iron or tin, but in practice this has been found unnecessary.

* * *

A dynamo-electric machine which gives one ampere at 25,000 volts has been constructed for the purpose of testing the insulation of the transmission line between St. Maurice and Lausanne, Switzerland. The armature, which is stationary, has an internal diameter of 580 millimeters, and a length of 300 millimeters. It consists of 48 Gramme coils, each with 500 turns of silk-insulated wire, 0.5 millimeter in diameter, the total resistance being 700 ohms. The commutator consists of 96 air-insulated segments, and is connected by rotating brushes to stationary slip rings. The rotating magnet has two poles, and is constructed of laminated iron. It takes eight amperes at 80 volts, and revolves at 600 revolutions per minute. An air blast is brought into play on the brushes to prevent sparking.—*Western Electrician.*

* * *

The Otis Elevator Co. have been awarded the John Scott legacy medical and premium by the Franklin Institute for their electric elevators for use in private buildings. These elevators are operated by pushing buttons, in the car and on the different landings, and thus render the services of an operator unnecessary.

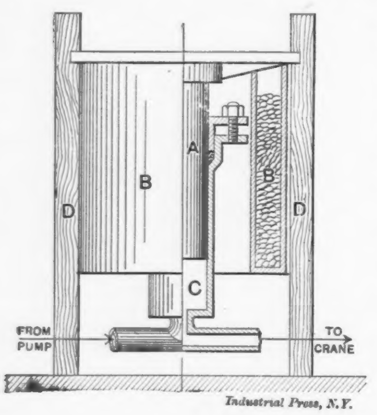
HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

17. H. E.—Please explain the construction and use of the hydraulic accumulator.

A.—The hydraulic accumulator, the simplest form of which is shown in half section in the cut, is used for storing up a large quantity of water under pressure to be used for operating cranes, elevators, punches and other hydraulic machinery. If a pump alone were depended on, it would have to be of sufficient capacity to supply the maximum demands for power, while with the accumulator a small pump may be used and the power stored up ready to be drawn upon as needed. The accumulator in no way increases the pressure but simply acts as a reservoir so as to make a large quantity of power always available.



The inlet at the left is connected to a steam pump from which the water enters the bottom of the cylinder *C* and forces up the piston *A*. Connected with the top of this piston is an annular chamber *B*, which is filled with scrap iron, or other heavy material, thereby producing the required pressure on the water in the cylinder. As the piston reaches the top of its travel, it encounters a tripping lever which shuts off the steam and stops the pump. When the crane, elevator or other machine is started the piston begins to descend and in so doing the pump is again started. So long as the demand for power is equal to the supply from the pump the water would pass directly from the pump to the machine without entering the accumulator, but should the demand exceed the supply from the pump the accumulator would at once make up the deficit. In the sketch the tripping levers and connections have been omitted, for the sake of clearness, the posts *D D* are simply guides for controlling the motion of the weight-cylinder.

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18. C. A. K.—Will you kindly tell me how to calculate the number of revolutions or parts of a revolution that must be made by the feed screw of a shaper for cutting diametral pitch racks. Please show how to make the calculation for a screw having single, double or triple threads, and indicate how a collar should be graduated by which the feed screw can be turned the necessary number of divisions to advance the rack the required distance in spacing the teeth.

A.—The same principle is employed in calculating the spacing for rack cutting in the shaper that is used in cutting the threads of diametral pitch worms in the lathe. The latter subject was fully explained in the September, 1902, number of MACHINERY in the How and Why department, to which we refer you. To make the subject of rack cutting as simple as possible, let us suppose at first that we have a rack of one diametral pitch and that the feed screw of the shaper is of one inch lead, or, in other words, that it has one thread per inch. Having determined how to space such a rack with this feed screw, it will be a simple matter to calculate the spacing for a feed screw having a greater number of threads per inch and for a rack of finer pitch than one. The circular pitch or distance from tooth to tooth of a rack of one diametral pitch is 3.1416 inches. Consequently the shaper table must travel 3.1416 inches every time a tooth is to be spaced, to accomplish which the feed screw must make three turns and .1416 of a turn more. This decimal expression 3.1416 is equivalent to the common fraction 22-7, very nearly, and so if we use gears in the ratio of 22 to 7, or say one gear with 44 teeth and one with 14 teeth, for turning the screw, the purpose will be accomplished. Put the small gear or pinion on the end of the feed screw and the 44-tooth gear on a pin attached to the frame in such a position that the two gears will mesh. Then one complete turn of the large gear will cause the small gear, and hence the screw, to turn 3.1416 times (approximately, the error per rack tooth in this case being about $1\frac{1}{4}$ thousandths).

In applying this principle the first step is to find how many turns the gear must make to space a rack of one pitch on the shaper that is to be used. To do this, measure the distance traversed by the shaper saddle for one turn of the screw, and note what fractional part of an inch it is. It makes no difference whether the feed screw has a single, double or triple thread; all that is necessary is to measure the distance moved for one turn of the screw and calculate accordingly. Suppose it is found to advance one-third of an inch, or one-third as far as assumed above. Then it is evident that the gear would have to be given three turns, instead of one, to space a rack of one pitch.

Having found how many turns the gear must make to space a one-pitch rack, the next step is to find how many turns the gear must make to space the particular rack to be cut. Suppose a 6-pitch rack is to be cut, making it necessary to move the table only one-sixth the distance required for a one-pitch rack. The gear would then have to turn only one-sixth as far; or, in the case last assumed, 1-6 of 3 turns, making 3-6 or $\frac{1}{2}$ turn. For another example, suppose the shaper saddle to move $\frac{1}{2}$ inch per turn of screw and that a 10-pitch rack is required. Then,

Turns of gear required for one-pitch rack $= 2 \times 1 = 2$.

Turns required for 10-pitch rack $=$ 1-10 $\times 2 =$ 2-10 $=$ 1-5.

The dial on the large gear should thus be graduated into fifths.

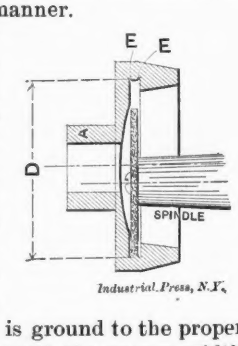
Instead of using the one-pitch rack as a basis for calculation, as has been done in the above explanation, it is more customary to take the 4-pitch rack as a basis, this being as coarse as is often cut on a shaper. In this case we could use a gear of 11 teeth on the pin in place of the 44-tooth gear, so that one turn of the gear would advance the rack only one-fourth as far as before. For example, suppose we are to cut a rack on a shaper, the saddle of which advances $\frac{1}{2}$ inch per turn of screw. To cut a 4-pitch rack we should have to turn the gear $2 \times 1 = 2$ times. To cut an 8-pitch rack, $2 \times$ 4-8 $= 1$ turn; a 6-pitch rack, $2 \times$ 4-6 $=$ 8-6 $=$ 1 1-3; a 10-pitch rack, $2 \times$ 4-10 $=$ 8-10 $=$ 4-5 turn, and so on.

If it were found that the table fed one-third inch per revolution of screw, then for 6-pitch rack, $3 \times$ 4-6 $=$ 12-6 $= 2$ turns; and for a 10-pitch rack, $3 \times$ 4-10 $=$ 12-10 $=$ 1 1-5 turns.

Answer to No. 11.

In answer to inquiry No. 11, by Baer and Remple, in the February number of MACHINERY, we have received the following, from H. G. Stoner, Waynesboro, Pa.:

A.—Referring to the sketch, I would suggest that the race *D* be first turned as near to size as possible, leaving only enough stock to allow for truing after hardening. The corners of the race should be turned relieved as shown at *E*, *E*. Harden the piece in the usual manner.



The universal grinder is best adapted for finishing, as almost any of these machines can be arranged to chuck the piece in the headstock and revolve with it while the internal grinding attachment carries the grinding wheel. For this particular job what is known as an elastic emery wheel is the best adapted. This should be slightly narrower than the width to which the race has been turned in order to allow it to go to the bottom. After the race is ground to the proper diameter the wheel is moved sidewise until the proper width is attained. Elastic emery wheels can be made very narrow and accurate by grinding the faces in the same manner as is employed for grinding the sides of metal slitting saws. With the above method a very accurate job can be produced and if but a small amount of stock is left for grinding, the pieces can be finished rapidly.

NEW TOOLS OF THE MONTH.

A RECORD OF NEW TOOLS AND APPLIANCES FOR MACHINE SHOP USE.

NEW THREE-FOOT RADIAL DRILL.

The accompanying illustrations show a new 36-inch radial drill that has just been brought out by the Mueller Machine Tool Co., Cincinnati, Ohio. The column is made of one piece and is fastened to the base so that it does not revolve as is customary in most radials. On the inside of the column, four webs extend the full length and thus enable it to resist firmly

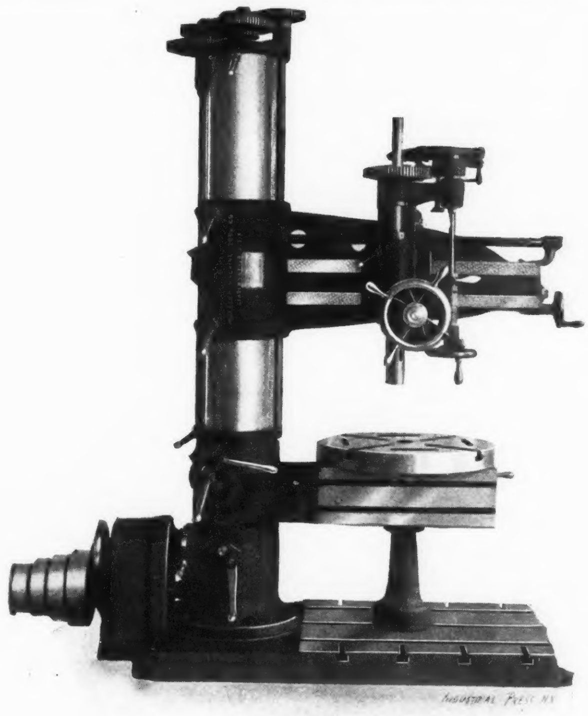


Fig. 1. Mueller Three-foot Radial Drill.

all strains even when the arm and spindle are at their maximum positions. Just above the swinging platen, around the column, there is a graduated ring that revolves with the arm. This is a useful feature when duplicating parts which are held in fixed jigs clamped on the base or platen, as the spindle can be brought exactly to any former position by readings on the 0 line on the stationary column.

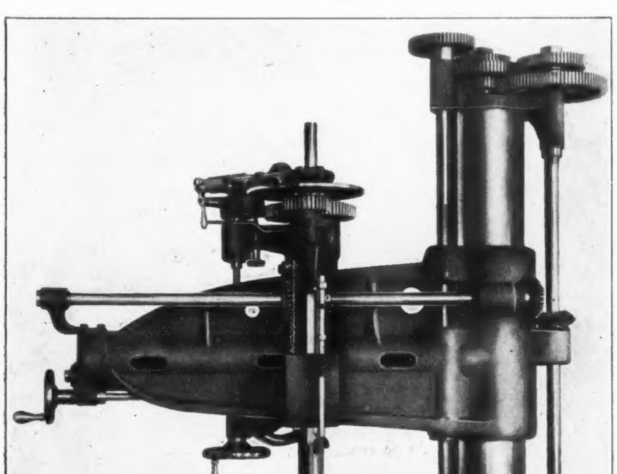


Fig. 2. Back View of Arm.

The arm is made in pipe section, its upper brace being as near as possible to the head while the lower one is at the outer edge. This arrangement will be seen by referring to Fig. 3, which is an end view of the head and arm. This disposition of the ribs of the arm prevents it from twisting when receiving the upward pressure of the spindle in drilling. The arm is supported by a cap resting on roller bearings. Both make a complete circle about the column and can be instantly locked by fixed binder levers. The arm is lowered at nearly three times the elevating speed by means of a screw which is driven from the center shaft without the use of any intermediate gears. A bronze plate, attached to the side of the arm, shows the operator the correct speed for drilling either cast iron or steel.

The head is traversed by means of a screw that engages with a revolving dial on the outer end of the arm, enabling the operator to bring the head within .001 inch to a required position. Provision is also made for locking the head to the arm. The spindle is counterbalanced and has quick advance and return. When used for tapping, it is impossible to accidentally engage either automatic or lever feed and the danger of breaking taps is thus eliminated. A gage screw causes the spindle to stop when the tap reaches the bottom of a hole. Sixteen spindle speeds are available, ranging from 18 to 370 revolutions per minute, and the change from fastest to slowest occupies only about four sec-

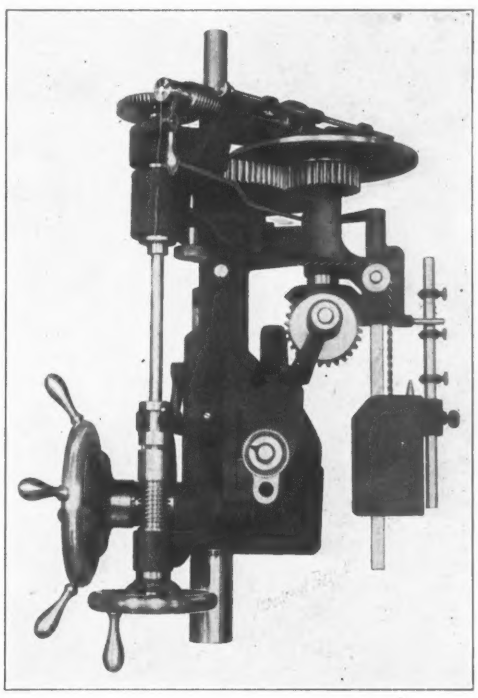


Fig. 3. End View of Arm and Head.

onds. The speeds are changed, and the lowering and elevating mechanism operated, by a single starting lever which extends from a loose ring encircling the column above the swinging column. This ring is adjusted to any position about the column and is connected, on the inside, to a rod which operates the two noiseless friction clutches on the shaft *N*, Fig. 4. When the spindle is not in use the lower driving shaft *Q* is the only one in motion. When the starting lever is pushed to the left, the friction clutch *P* causes gears *G* and *H* is to drive shaft *N* at low rate of speed. When lever is pushed to the right the same clutch causes gears *I*, *L*, *K* and *J* to drive shaft *N* at a higher speed. By allowing the gears *C* and *B* to mesh, two changes of speed are delivered to the spindle and by meshing gears *E* and *A* two faster speeds are given, thus obtaining four speeds from each of the four steps of the cone, or 16 changes in all. When a reverse motion of the spindle is required, the tumbler *O* is changed, causing gears *L*, *M* and *J* to run shaft *N* in the opposite direction and at an increased speed. The crank shown on the lower part of the column is used to lower the shaft *R*, inside of the column. In elevating or lowering the arm, this crank is pushed to the right, causing the shaft *R* to engage gears *D* and *F*, which drive the elevating screw.

The automatic feed, the details of which are most clearly shown in Figs. 2 and 3, is driven through a friction plate fastened to the spindle pinion shaft. By moving the small friction wheel from the center to the outer edge of the friction plate, by means of a graduated rod, any feed from 0 to .23 inch per revolution of the spindle can be obtained. The amount of friction required for light or heavy drilling is regulated by a knob shown at the right of the feed shaft in Fig. 3. An automatic trip is provided which prevents feeding of the spindle after reaching the limit of its travel. A graduated bar, attached to the counter weight, carries several dogs to trip the spindle as often as desired. The automatic feed can also be tripped by the lever shown on the vertical feed rod.

The platen is usually plain but can be furnished with round or swivel table if desired. It has a round boss in the center that can be bored to receive bushings for boring bars which pass through the center of the supporting stand on the base. The net weight of this drill is about 3,800 pounds.

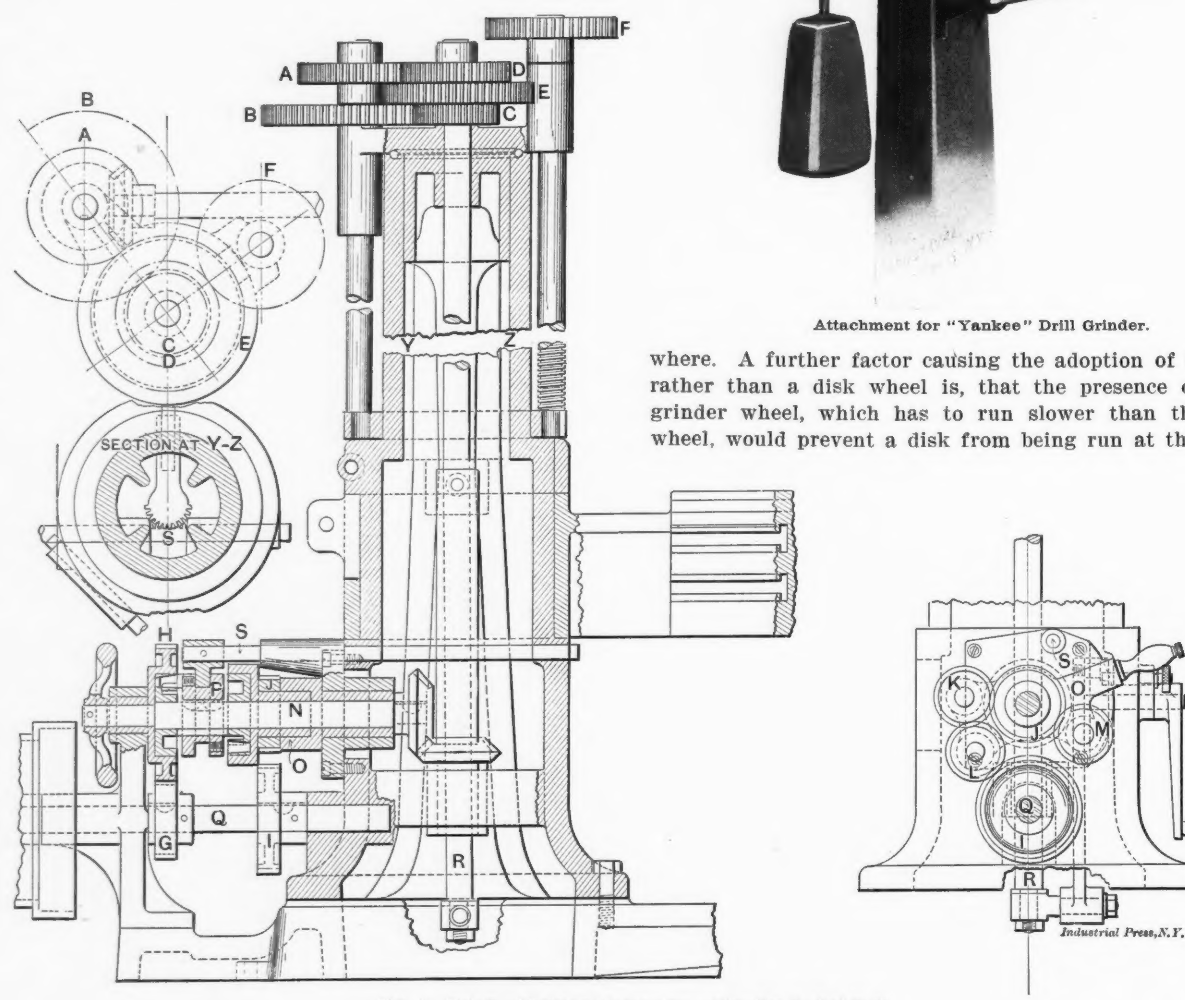


Fig. 4. Detail of Driving Mechanism of Mueller Radial Drill.

GRINDING ATTACHMENT FOR TWIST DRILL GRINDERS.

The accompanying photograph illustrates a grinding attachment that the Wilmarth & Morman Co., Grand Rapids, Mich., have lately designed for use with their "Yankee" twist drill grinders. As will be seen, arrangement is similar to that used in the disk grinders and consists of a table, with its supports, which oscillates about a stud and is kept in a vertical position by means of a swinging counterbalance. Two tables are furnished; a flat one that has a ridge at the side against which to square the work, and a V-shaped table for holding round or odd-shaped pieces. These tables may be quickly interchanged, without the use of a wrench, and are adjustable for angles as well as up and down. Cutters, chasers, punches, dies and similar pieces that would otherwise be planed, milled or filed may be readily ground with this attachment. A collar, adjustable on the stud, limits the movement of the table toward the wheel and a shield keeps the adjusting mechanism free from grinder dust.

A cupped wheel is used and as the work is moved completely across its face there is no tendency for it to wear out of true so that it possesses the advantages of the emery-paper faced steel disk. When the wheel has been worn back to the web a plain wheel remains which may be used up else-

Attachment for "Yankee" Drill Grinder.

where. A further factor causing the adoption of the cupped, rather than a disk wheel is, that the presence of the drill grinder wheel, which has to run slower than the ordinary wheel, would prevent a disk from being run at the high rate of speed at which it is the most efficient. For use in shops where the drill grinder is already installed the builders are prepared to furnish the grinding attachment on the column, as shown in the cut, but without the drill grinding feature, a plain wheel being substituted for the drill grinding wheel.

MULTIPLE INDEX CENTERS.

Multiple index centers are in common use for manufacturing and are very valuable for such purposes as fluting taps, reamers or similar work. The set of multiple centers shown in Figs. 1 and 2, P. 441, are capable of holding and indexing simultaneously four pieces ½ inch or less in diameter. The head spindles are geared together and are operated by turning the ball-handle on one spindle upon which is mounted the dial. The index-pointer is adjustable so that several indexes are carries on one dial. The tailstock is adjustable along the base-plate, and the plate has a countersunk bolt for securing to a milling machine slide. The tail-spindles

have individual quick redrawal by lever and come forward by spring. They are all bound simultaneously by one handle.

The taps are held by the square end and supported at the tail-spindle end by female centers for small taps and male centers for the large ones. Both head and tail-spindles are fitted with No. 1 Morse taper centers, which can be quickly changed and make it possible to set up for large or small work on the same centers. The head-spindle center *A*, has a taper countersunk hole and across this are two saw cuts at right-angles. The square end of the tap is centered in the taper hole and the corners of the square catch in the saw cuts which dog it round. The tail centers, in practical use, are milled down close to the center line, to give access to the cutter.

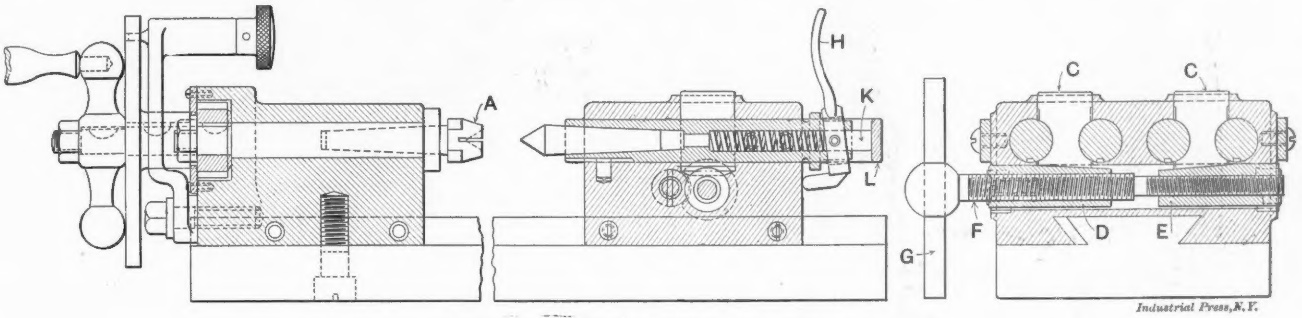


Fig. 2. Section through Multiple Index Centers.

The method of binding the tail-spindles simultaneously is shown in Fig. 2. Between each pair of spindles is a plug *C*, fitted with a slight looseness. The lower ends of these plugs are bevelled, and rest on two bushings, *D*, *E*, which are tapered on the upper side to match the incline of the plugs. The bushings are fitted with a right and left-hand screw, *F*. When the screw is turned by the handle *G*, the bushings are forced to approach each other and this forces up the plugs, which jam equally against both spindles. When the screw *F*, is turned in the other direction the spindles are positively loosened. The tail spindles are moved by the levers *H* and each is bored out and carries a spring plunger *K*, which abuts against the yoke *L*. The centers are manufactured by the Garvin Machine Co., New York, N. Y.

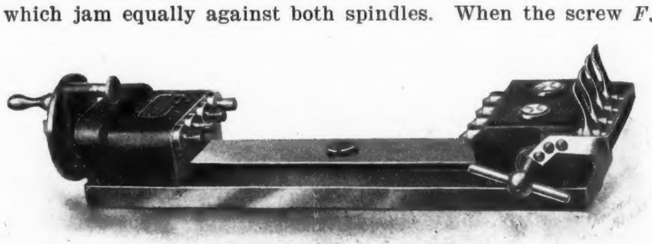


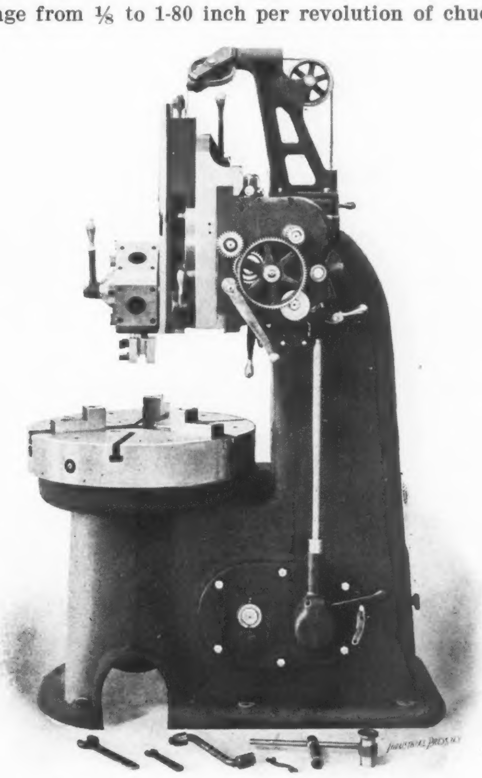
Fig. 1. Multiple Index Centers.

VERTICAL BORING AND TURNING MILL.

The half-tone herewith illustrates a new vertical boring and turning mill that is manufactured by the Colburn Machine Tool Co., Franklin, Pa. This mill swings work up to 34 inches in diameter and will swing 14 inches under the cross rail, while the extreme height from chuck to turret is 22 inches. The chuck has three jaws which may be operated universally or independently. The driving gear is fastened directly to the chuck so that no twisting strain is brought upon the spindle. The driving gears and back gearing are all contained in the frame of the column where they are protected from dirt and chips. A door at the back of the column makes it possible to inspect the gearing without dismantling the machine.

The turret slide has a travel of 18¾ inches, with automatic adjustable stops for tripping the feed. A counterbalance weight, suspended within the column and attached to the turret slide, facilitates raising and lowering the turret head. The turret is five-sided and bored for carrying five tools, while the sides have tapped holes, thereby providing a means for fastening special tools to the turret. An ingenious feature that has been incorporated in this machine is the arrangement for swinging the turret slide to any angle. To do this, the counterweight cable is clamped to the back of the column and then, when the head is fed out by the cross feed screw the cable pulls the top of the slide over until the proper angle is reached. This does away with the trouble of prying the head over with a bar, as is necessary in machines not so equipped, and renders possible a very quick and accurate setting of the turret slide.

The cross slide has a travel of 15½ inches, automatic adjustable stops for tripping the feed, and means for clamping the slide to the rail without the use of a wrench. Both vertical and horizontal feeds are positive, gear driven, and provided with automatic adjustable stops. There are eight changes of feed for each speed of the cone. These changes are effected by means of two levers, one giving four changes and the other increasing them four to one. The entire feed mechanism may be stopped, started or reversed by means of a hand lever at the base of the machine. The feeds may be stopped at five different points in the train; by using the feed trip lever, by withdrawing the pinion on feed screw or feed shaft, by dropping out the feed-change lever, or by placing the feed-increase lever or feed reverse lever in central position. The vertical feed has a range from ⅛ to 1-80 inch per revolution of chuck, and



Colburn 34-inch Vertical Boring and Turning Mill.

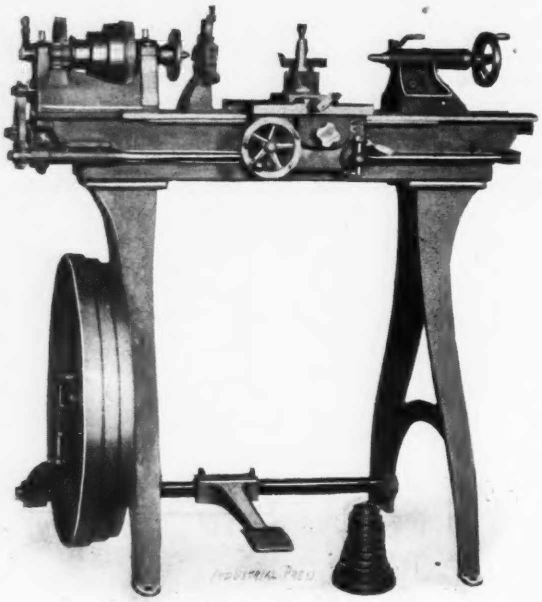
the horizontal from ¼ to 1-40 inch per revolution. An index plate, fastened to the machine in clear view of the operator, indicates the feed. A screw-cutting attachment may be quickly applied to the machine, the bank of gears provided being arranged to cut from 4 to 14 threads per inch. The net weight of this machine is about 5,500 pounds.

NEW FOOT-POWER ENGINE LATHE.

The foot-power engine lathe illustrated in the accompanying half-tone has lately been brought out by the W. C. Young Co., Worcester, Mass. Although a foot-power machine this

lathe is equipped with all of the appliances of a regular power-driven engine lathe.

It is back-geared, in the ratio of 8 to 1, and is supplied with a full set of screw-cutting gears, being capable of cutting from 6 to 72 threads per inch, or 6 mm. to .5 mm. when fitted with a metric lead screw. It has power cross feed and is furnished



Foot-power Engine Lathe.

with plain or compound rest as may be desired. A taper attachment, of improved design, is constructed for use with this lathe.

The lathe is furnished with either 4- or 5-foot bed and will take, between centers, 24 and 36 inches for the respective lengths of bed. The swing over the bed is 10 inches and over the carriage, 6½ inches.

NEW SELF-OPENING DIE.

The illustrations, Figs. 1 and 2, present a new self-opening die that is being manufactured by the Maines Machine Co., Philadelphia, Pa. It is designed for use on lathes and screw machines as well as on other screw-cutting machines, in place of solid dies. It can be used for cutting either right or left-hand threads of standard or special pitch. A micrometer adjustment is provided at one side of the head, by which quick and accurate variations can be made in the diameters of the

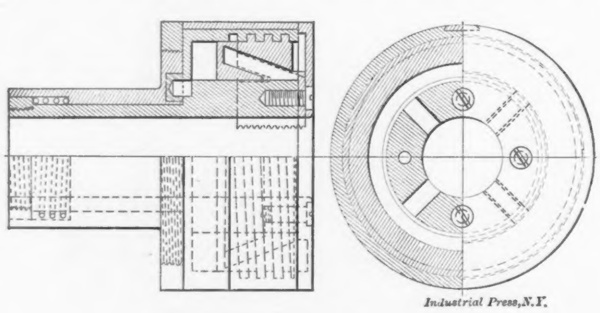


Fig. 1. Maines Self-opening Die.

thread, for tight or loose fitting screws, as desired, and as the dies are adjusted simultaneously, the greatest accuracy is assured. The construction of the die and mode of holding are such as to allow a thread to be cut flush up to a shoulder if desired, and as the shank of the die head is made hollow, any length of thread may be cut which the travel of the lathe or turret slide will permit.

The dies are opened automatically by simply stopping the travel of the carriage or turret slide, and in regular practice, the turret stop screw is set to govern the travel of the turret, and at the same time, the length of the thread to be cut, although the die may be opened at any point on the cut by simply holding back on the turnstile or lever by which the carriage or turret slide is moved, the dies being closed again by means of a small handle provided at one side of the head; or they may be closed automatically. The distinctive feature of this die head is the arrangement of the chasers which are so placed as to receive the thrust on top, thereby giving it the strength of a solid die.

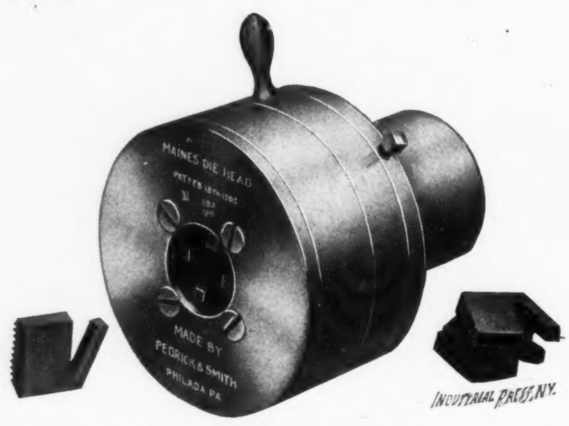


Fig. 2. Maines Self-opening Die.

CENTERING AND DRILLING MACHINE.

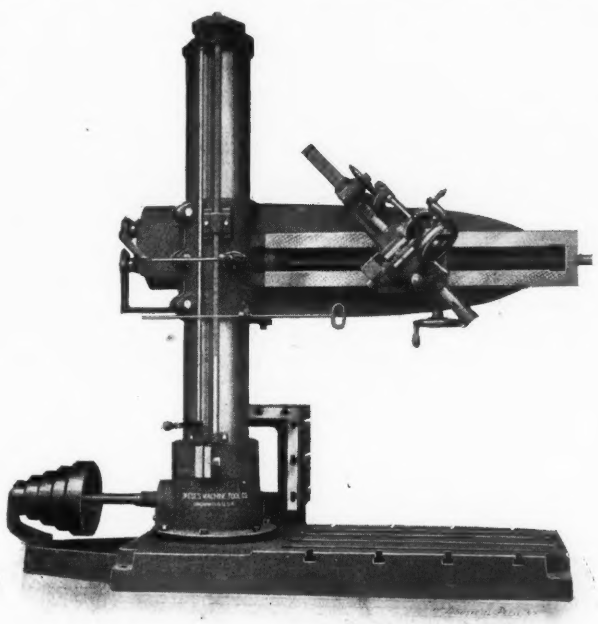
The Nazel Machine Tool Works, Philadelphia, Pa., have recently placed upon the market the centering and drilling machine illustrated herewith. This machine consists of an upright column or stand to which the bed is securely bolted. Upon this bed is mounted a drilling head and a two-jaw centering vise which can be clamped at any point along the length of the bed by a half turn of the binding nut. The bed has a bevel on the inside of the shears so that clamping the vise in this way insures accuracy and prevents any unnecessary strains on the shears. No matter how much wearing may take place, the center of the vise will always be in perfect horizontal alignment with the spindle. The form of the vise is such that not only round but square and octagonal-shaped pieces may be held equally well. The faces of the jaws are steel lined.

New Centering and Drilling Machine.

The spindle is provided with an adjustable stop collar for drilling any number of holes to the same depth. Combination center drills and countersinks are used so that but one operation, consisting of a simple movement of the hand lever, is necessary to perform both drilling and countersinking. The machine has a two-step cone and is furnished with short-work rest and drill chuck. An extension floor rest, for long work, can be supplied if desired.

NEW FIVE-FOOT RADIAL DRILL.

The Dreses Machine Tool Co., Cincinnati, Ohio, have just brought out the 5-foot radial drill that is illustrated in the accompanying half-tone. This machine is driven from a cone shaft, a central shaft in the column, spur gears on top and another pair of miter gears connecting the outside shaft with the back gears and the horizontal shafts. The inside column or stump extends nearly to the top of the column.



Five-foot Radial Drill.

The bottom is as large in diameter as is consistent with the strength of the outside column and is of small diameter on top so as to decrease friction and insure easy horizontal movement of the arm. The outside column rests on taper roller bearings which are alternately full size and slightly smaller in order to obviate friction between them. The inner and outer columns, near the base, are turned of the same diameter and the clamping band encircles both so that by means of the one screw, shown in front, horizontal movement is firmly arrested without injuring the anti-friction bearing.

The adjustable handle rod, shown below the arm, operates a double friction and starts, stops, engages the back gears,

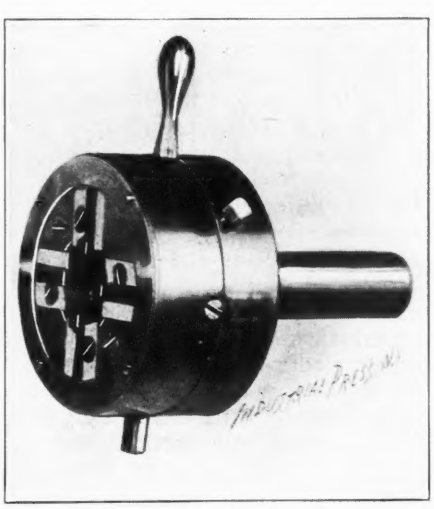


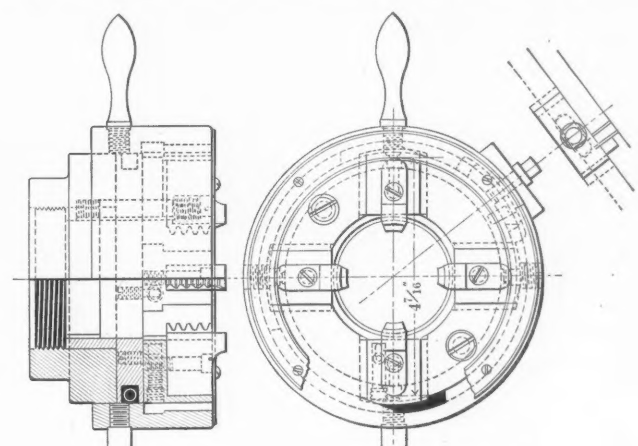
Fig. 1. Self-opening Threading Die.

and reverses the spindle in the ratio of the back gears, all while the machine is in operation. The handle shown in front of the sleeve encircling the column, operates another double friction clutch by means of which the machine is set for reversing when tapping; and it can also be used for direct tapping, especially for small holes where it is desirable to run the tap forward at a high speed and back out at but slightly increased velocity. The spindle has positive geared feed which can be varied while drilling, by the handle shown in the slot. It has also a quick return which is operated by the large hand-wheel and it can be instantly engaged or disengaged by the handle above.

These machines are also made full universal, motor and variable speed countershaft driven. The latter can also be applied to the central shaft so that the arm can make a complete revolution without obstruction.

SELF-OPENING THREADING DIE.

The Modern Tool Co., Erie, Pa., have for some time been manufacturing the self-opening threading die shown in Figs. 1 and 2, but to most readers its design and construction will be new. Its features of excellence are its simplicity, strength, ease of changing the chasers, and permanency of setting. The chasers are mounted in four grooved blocks having radial movement and which move with the chasers when the die is opened and closed. The chasers are held in the chaser blocks by screws, but bear at their outer ends against the solid metal of the blocks, so there is no side stress on the screws. The blocks are in turn supported by the cam ring which takes the thrust, due to the cut, directly in line, thus avoiding all ten-



Industrial Press, N.Y.

Fig. 2. Detail of Self-opening Threading Die.

dency to cant over and make the chasers cut tapering threads when the die becomes worn. The chasers being mounted in the grooved blocks, all wear due to the movement of the cam ring is taken by the blocks, so that there is no wear on the outer ends of the chasers.

Threads may be cut flush to a shoulder and any length of thread may be cut since the shank is made hollow. The die is adapted to use on turret lathes and screw machines, being opened automatically when the limit of motion of the turret is reached. It may be closed by hand or automatically by a pin set opposite the handle which engages with the turret slide as the turret revolves. Adjustment is provided for varying the size of the thread for tight and loose fits.

BENCH DISK GRINDER.

The use of the disk grinder, employing a steel disk covered with emery cloth or paper, is increasing from day to day, and

Bench Disk Grinder.

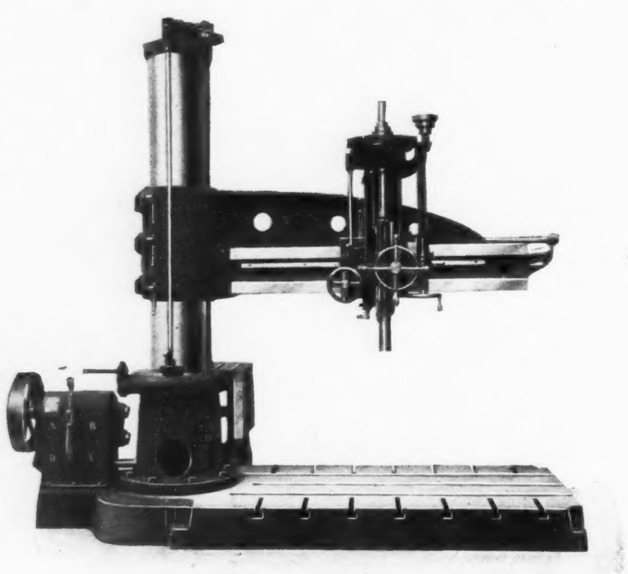
most of the builders of grinding machines are now combining the regular emery wheel grinder with the disk machine. The bench grinder, presented in the half-tone on page 443, carries on one end of the spindle a steel disk and on the other the regular emery wheel. The emery wheel is used for ordinary grinding and for roughing off the work before it is applied to the disk. The disk is adapted to grinding drop forgings and castings of all kinds and for finishing brass, copper, machine steel, aluminum and such work as gibs, nuts, wrenches and the various parts used in electrical construction.

The table has a rocking motion, which distributes the grinding to the full surface of the disk, or it can be clamped rigidly in position. It can also be set at any angle from 45 to 90 degrees. The emery paper or cloth can be secured to both sides of the disk by a quick drying cement, clamped in a press furnished for the purpose. A cup wheel can be used, in place of the disk, when desired, thus allowing the machine to cover a large range of work. This grinder is built by Delivouk & George, Chicago, Ill.

A NEW SPEED CHANGING MECHANISM APPLIED TO THE "AMERICAN" RADIAL DRILL.

The illustration shows the latest form of radial drill that has just been placed on the market by the American Tool Works Co., Cincinnati, Ohio. The drill itself embodies all of the features of the "American" radials, to which has been added the improved form of speed changing mechanism which takes the place of the ordinary cone pulley.

The device in brief is as follows: Two sets of friction clutches are controlled by the two levers shown on the front of the speed box. These two levers act independently and make it impossible to throw in any conflicting clutches, and so render a non-interfering device unnecessary. The friction



American Tool Works Company's Radial Drill with new Speed Changing Mechanism.

clutches are of their double band type which have double the transmitting power of any other friction and when properly adjusted, form a practically solid connection. They are engaged or disengaged with very little effort through the medium of the levers as shown. The upper lever, thrown either toward *A* or *B*, communicates two rates of speed from the top shaft, through intermediate gearing to the lower shaft, the clutches on this shaft running at different speeds by reason of the different ratio of their gears. Then by throwing the lower lever toward *C* or *D*, each of the two speeds communicated by upper lever can be made to give two additional speeds to the lower shaft which carries the power to the machine. This, with double friction countershaft and back gears on the head, gives sixteen changes of speed to the spindle, arranged in geometrical progression, giving a wide range for drilling, tapping and boring. The makers are prepared to equip any of their drills with the above method of mechanism.

TIDAL ENERGY CONVERTED TO POWER.

Proceedings Canadian Society of Civil Engineers.

In a paper read before the last meeting of the Canadian Society of Civil Engineers, C. P. Baillairge discusses the power of the tides and shows why it has never been used to any extent and why, in his opinion, it is not likely to be. He considers briefly tide mills, in which the water from the rising tide is allowed to flow up a stream or tributary to the sea, where it is retained by a dam, having openings that are closed just as the tide turns to go out; and concludes that at best they are an expensive mode of getting power. He then takes up the two methods of actuating a rotating mechanism by means of the tides and of storing energy by using weighted floats which rise as the water rises and which in descending give out their potential energy to some form of mechanism.

The average direct motion or velocity obtainable at Quebec and vicinity may be taken at twelve feet rise and twelve feet fall or twenty-four feet per tide, or say, per twelve hours; though, due to the retardation of the moon's motion, the tides may be some fifty minutes later on each successive day. This is equivalent to a motion of two feet per hour; or taking it another way, the rising and falling tide can only cause one revolution of a wheel in twelve hours, if actuated by crank action.

Some motion or rotation of a wheel can be conceived of as actuated from a floating body rising and falling with the tide and operating a vertical rack which meshes in a pinion on the shaft of the driving mechanism. By this means several revolutions of the shaft might be obtained per diem.

But the net duty derivable from such machinery, due to loss by friction, is but about 85 per cent. of the initial power and the mechanism in this case, to arrive at any reasonable velocity for manufacturing purposes, must at least be quintupled; and if this same allowance for retardation by friction obtained throughout, the loss would not be less than five times 15, or 75 per cent., leaving but one-quarter of the initial power to the good.

If, however, the loss by friction, as may sometimes be warranted, be taken at only 10 per cent. instead of 15, there would still be but four horse power realized out of every ten of the direct lifting or falling power of the tide, and this alone is enough almost to dissuade any one from falling back upon or appealing to the tides for a lucrative mode of creating or utilizing power; and if we attempted to reach such higher velocities of revolution as required for electric power purposes, it is easy to see how the whole or nearly the whole of the initial power of the tides might be absorbed in so doing and not enough of it remain to make it a paying business.

Therefore, is it probable that if the tides have not as yet been utilized by man, it is because he has by mental process gone through the line of reasoning here laid down, and thus become convinced of the futility of making the trial, especially under the discouraging consideration that not only is there the loss by absorption by rubbing surfaces, but the other allowance of 10 per cent. for wear and tear, and consequent repairs, etc.

But as yet we have said nothing of what this power of the tides really is; this apparently, or at first sight, is almost irresistible power, since with the tide rises every thing upon its surface, even to a twenty or thirty thousand ton vessel of war, and which would similarly lift a city if built upon the water on a water-tight platform with depth of water sufficient to allow it to sink till the weight of water displaced were equal, as with a vessel, to the weight supported.

This great power, however, is only apparent as the tide wave has no greater power than that which is required to raise its own weight of water to the average height of one-half a tide or one-half the weight of water to the full height of amplitude; the weight of the vessel or other object on the water being supported by the water, irrespective of the lifting power of the tide, as represented by the hydrostatic pressure exerted as above mentioned, by the weight of the equivalent volume of water displaced; so that where the vessel or object rests or floats, the weight to be raised by the tide is the same as elsewhere or as where there is nothing on its surface.

In other words, the lifting force of the tide per square foot

Brown & Sharpe Mfg. Co.

Providence, R. I., U. S. A.

Some Reasons Why the Best Machinists use Tools Stamped "B. & S. Mfg. Co."

They are Accurate and Trustworthy---Features that are first considered by a Machinist.

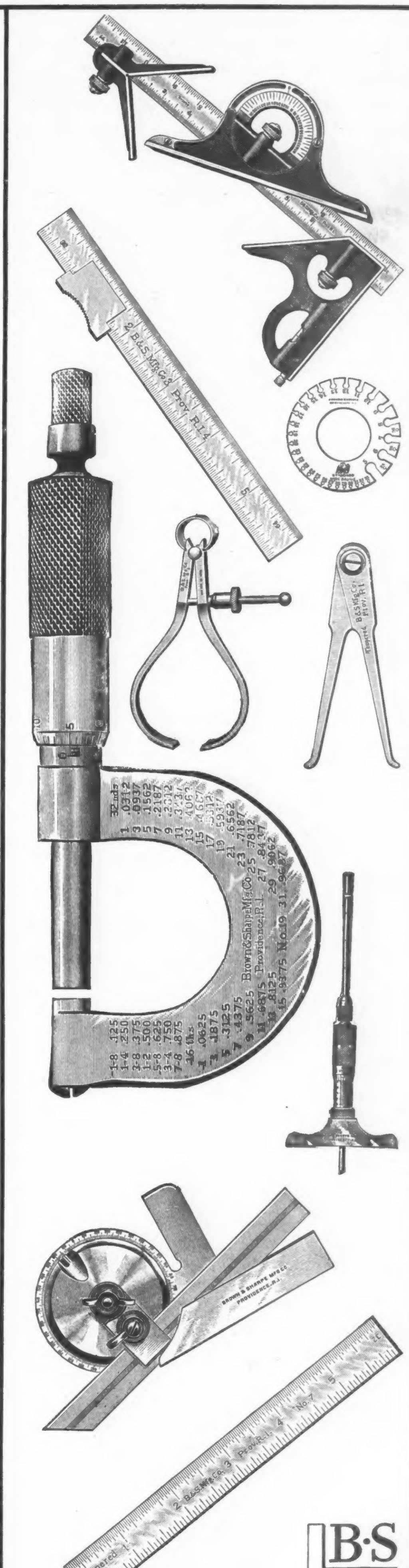
They are Designed by Expert Mechanics to meet the requirements of the work for which they are intended.

They are Made with the purpose that they shall be the **Best** of their **class.**

They are sold at **Prices** that are **Right.**

A Complete Line of our Tools is carried in stock by Leading Hardware and Supply Dealers. This is convenient as it often saves delay in delivery.

No. 103 Catalogue shows the complete line. It is furnished by Dealers, or we shall be pleased to mail it to any address.



is, for an average rise and fall of twelve feet, equal to twelve cubic feet of water or 750 pounds raised to an average height of six feet, making 4,500 foot pounds. But we also have the same power developed in the falling tide as in the rising tide and the 4,500 foot pounds must thus be doubled to represent same power developed in the falling tide as in the rising tide in twenty-four hours we thus get at the fact that every square foot water surface exercises 18,000 foot pounds in twenty-four hours.

A horse power is equivalent to 33,000 pounds raised to the height of a foot in one minute and thus every square foot of water surface in such a tidal river as the St. Lawrence is a source of power only equivalent to about one-half or two-thirds of a horse power in twenty-four hours.

Calling it equivalent to one-half horse power in twenty-four hours and remembering that the value of a horse power is 33,000 foot pounds per minute and that there are 1,440 minutes in one day of twenty-four hours, it is evident that double 1,440 or 2,880 square feet of float area would be necessary to secure one horse power continuously during twenty-four hours. We therefore arrive at the conclusion that, when running, as would be usual, during eight or ten hours out of the twenty-four, it would require an area of from eight hundred to one thousand feet or thereabout, of water surface, to represent one horse power or a float of say forty or fifty feet by twenty feet, or for one hundred horse power say again one of eight hundred to one thousand feet by one hundred.

And, therefore, if the writer's figures be correct, it is not to be wondered at that the power of the tides has never as yet been, nor is ever likely to be, economically utilized for industrial purposes.

* * *

NEW TRADE LITERATURE.

The Northern Electrical Mfg. Co., Madison, Wis. Booklet No. 31 describing and illustrating the Northern direct-current generators which are built in all standard sizes and in belted and engine types. The booklet is sent free on request.

The Betts Machine Co., Wilmington, Del. Catalogue No. 14 of improved slotting machines. They are built in the following sizes: 8-, 10-, 12-, 15-, 18-, 21-, and 24-inch and can be arranged to be electrically driven, if desired.

A. J. Polk & Son., Millersburg, Pa. Catalogue and price list of screw plates, taps, dies, reamers, milling cutters, etc. These are all described and illustrated, and the company call attention particularly to their common sense screw plate of which they are the inventors.

Baker Bros., Toledo, O. Catalogue No. 3B of drilling, boring and tapping machinery. Here are shown five styles of drill presses, various sizes of tapping and boring machines for large and small work, several sizes of chucks for holding flanges, a locomotive rod boring machine, built in two sizes, etc. The company state they will be pleased to send this catalogue to anyone interested.

The Whitcomb Mfg. Co., Worcester, Mass. Standard size catalogue of the Whitcomb planers. Eight sizes of these are shown, from the 17-inch to the 48-inch, and the 36, 42 and 48-inch planers are furnished with or without second belt drive, as desired. Several pages are devoted to a full description of the Whitcomb planers. The catalogue is printed on heavy coated paper, the illustrations are handsome, and it presents in general a most attractive appearance.

The Challenge Machine Tool Co., Inc., Philadelphia. Circular illustrating the "Challenge" emery wheel dresser, accompanied by small section of emery wheel showing the grooved surface that can be produced on the periphery of the wheel with this dresser. It is claimed that a wheel grooved in this manner is 25 per cent. more efficient than the ordinary smooth-faced wheel. The circular also describes the line of combination grinders manufactured by the company.

E. G. Smith, Columbia, Pa. New edition of booklet of Columbia calipers. A number of vernier calipers of various sizes and styles are shown and described. Spherometers, micrometers and the "Which Way" pocket level are also illustrated. Some testimonials of the satisfaction expressed by users of these various products appear, and a page is devoted to the Tripoli germ-proof filter, No. 4, also manufactured by Mr. Smith. This booklet will be cheerfully sent to any-one interested.

The Binsse Machine Co., Newark, N. J. Catalogue No. 2, 1903, of the "Binsse" horizontal boring machine. These tools are manufactured in three sizes: The B machine with 2½-inch, the C with 3¼-inch and the D with 4-inch bar. Sizes No. 3, 5 and 9 and their different parts are illustrated. Then follow examples of work that can be done on this machine, such as boring drill jigs and off-set brackets, drilling worm boxes and right and left worm shaft bearings, etc.

Pratt & Whitney Co., Hartford, Conn. Leaflet bearing a picture of the fine new building erected by the company for the manufacture of taps, dies, milling cutters, reamers, etc. The leaflet asks the pertinent question: "Can a small toolroom compete with a big factory?" the inference being, of course, that it cannot. A toolroom is a necessity for every well-ordered machine shop for the purpose of keeping tools in repair, but as a manufacturing proposition it is "not in it." The new building practically doubles the small tool department capacity of the company, which was already large.

The Brown & Sharpe Mfg. Co., Providence, R. I. Catalogue, 1903 edition, of the company's machines and tools. It contains 458 pages, has been thoroughly revised and considerable matter has been added. Its size, 5¾ x 3¾ makes it a volume convenient to handle, and the numerous tables and other useful information it contains render it valuable as a work of reference. It would not be possible to enumerate all the products described and illustrated in this catalogue, which those interested may secure, without charge, upon application. A very complete index is published at the beginning of this work, and a colored insert contains the principal additions of the past year to the various lines of machines and tools previously manufactured.

Hammacher, Schlemmer & Co., New York. Catalogue 180, of tools for machinists, metal-workers, carpenters, cabinet-makers, wood-workers, wood-carvers, patternmakers, jewelers, plumbers, gas-fitters, upholsterers, sculptors, masons, modelers, painters, paper-hangers, etc. This catalogue which is a large book of over 800 pages, handsomely bound in red cloth, embraces the large line of tools and mechanical supplies handled by this company, who have been in business in New York since 1846. The index alone covers 19 pages which gives an idea of the number of subjects catalogued. The book is profusely illustrated with cuts and is sent free to all manufacturing concerns. Private buyers can obtain copies by sending 60 cents which will be refunded when purchases to the amount of ten dollars have been made.

The Warner & Swasey Co., Cleveland, O. General catalogue 1903 of machine tools. This is a very handsome catalogue, printed on heavy coated paper and containing a large number of excellent halftone engravings. Herein are illustrated the hollow hexagon turret lathe; the 30-inch vertical turret machine; turret screw machines Nos. 1 to 6; turret lathes with or without automatic chuck, geared-friction head or automatic feed; forming turret lathes of 12-, to 18-inch swing; three sizes of universal turret lathes; a two-spindle and a four-spindle valve milling machine; an automatic boring and tapping machine, made only to order; double head key lathes; a manufacturing milling machine, a cutting off machine; a horizontal boring machine, etc. Matter descriptive of these various machines, of their parts, and of their operation is given. In their introduction the company invite all interested, to visit their works at Cleveland.

MANUFACTURERS' NOTES.

J. D. Hurley and A. B. Holmes, formerly connected with the Standard Pneumatic Tool Co., are now associated with the Rand Drill Co., New York, in the "Imperial" pneumatic tool department.

The Railway Appliances Co., Old Colony Bldg., Chicago, Ill. have appointed Mr. C. C. Murray to represent them at Pittsburg, where he will devote his time principally to the sale of the Q & C. pneumatic tools.

R. McCarty, formerly manager of the Bignall & Keeler Mfg. Co., Edwardsville, Ill., has resigned his position with that company and on April 1st assumes the duties of manager of the Stoever Foundry & Mfg. Co., Myerstown, Pa.

The R. D. Nuttall Co., Pittsburg, Pa., recently received an order from a prominent automobile company for 12,000 gears. They state that they think this is the largest individual order for gears ever placed.

The Cleveland Pneumatic Tool Co., Cleveland, O., are now located in their new plant, corner 2d and Hawthorne Sts., where they have greatly-increased facilities. Their new plant is up-to-date in every respect.

The Espen-Lucas Machine Works, Philadelphia, Pa., builders of machine tools, and special machinery, have bought the designs, machines, jigs, tools, etc., of the Franklin Machine Works, Inc., Philadelphia, and are prepared to supply these machines and other machine tools at short notice.

The O. K. Tool Holder Co., Shelton, Conn., have just added to their line a new holder which is ¾ inch x 1⅜ inches, known as size D, and also another size to their cutting-off tools, ⅝ inch x 1¼ inches, known as size C. The business of this company is increasing very rapidly, showing that their tools are meeting with the approval of users.

The Northern Mfg. Co., 253 East Eighth St., St. Paul, Minn., have been incorporated with a capital of $50,000, to do a general manufacturing business. Their specialties are Northern metallic packing, the Curran locomotive whistle and the Furhman-Nelson pneumatic motor, etc. The officers are: Alfred Munch, president; S. B. Mack, vice-president; S. R. Parslow, treasurer, and D. E. Anderson, secretary.

The American Tool Works Co., Cincinnati, O., have recently undergone some changes in the personnel of their management. Franklin Alter is president; Henry Luers, secretary and treasurer; J. B. Doan, general manager; A. E. Robinson, general superintendent. The company report that February's business was the largest month's business in their history. Extensive alterations are being made to meet their increasing needs. They have just brought out several new tools, and state they are much gratified at the success attending their introduction.

The Northern Engineering Works, Detroit, Mich., crane builders, report a large volume of business and an increasing demand for their electric traveling cranes. Among the orders recently received are the following: C. D. Jackson & Co., a 25-ton crane; the Detroit Shipbuilding Co., five cranes, of from 5 to 40 tons; the Allis-Chalmers Co., 12 cranes; the American Shipbuilding Co., 3 electric cranes. Also orders from P. A. Clum & Co., the C. & G. Cooper Co., and the Macbeth Iron Co. They are also installing their hand power cranes of the traveling and jib type.

The Philadelphia Pneumatic Tool Co., Philadelphia, Pa., have secured a contract from the Lake Shore & Michigan Southern Railway Co. to supply them with all the pneumatic hammers which they will use in the new Collinwood Shops and on the entire system for a period of one year. This contract is awarded after a competitive test of all the different makes of pneumatic tools. They have also received large orders for chipping and riveting hammers and drills from the Wabash, the Delaware & Hudson and the Central of New Jersey Railroads.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order.

AN INVENTOR of a new system of locomotives with extraordinary power upon 2 and 4 buggies, all wheels being drivers, desires the association of a capitalist for obtaining patents from different countries, and building of such engines. Address ANTHONY TITTEL, 2306 So. 11th St., St. Louis, Mo.

BOOK, "DIES AND DIEMAKING," 100 6x9 pages, $1, post paid; send for index. J. L. LUCAS, Bridgeport, Conn.

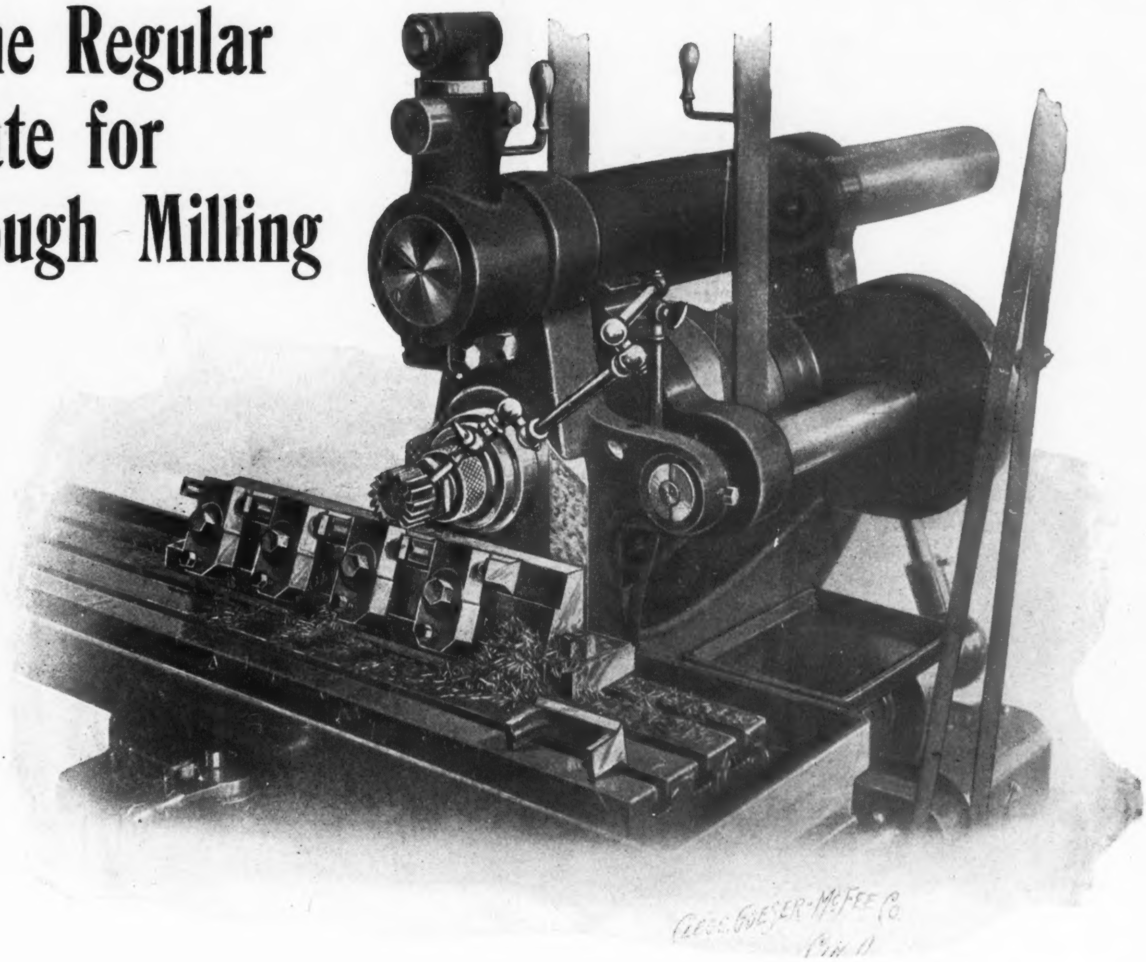
EXPORTERS to Germany desiring catalogs translated will find it profitable to address E. O. Reuleaux, Mech. Eng., Wilson, Pa.

EXPERIENCED advertiser, correspondent, and machine salesman, several years connected with leading manufacturing house, is open for engagement. A1 references. Address W. T., care MACHINERY, 66 West Broadway, N. Y.

FOREMAN.—First class mechanic desires position as foreman on any mechanical work. Position must be permanent. Address Foreman, care MACHINERY, 66 West Broadway, New York.

(Continued on page 448).

The Regular Rate for Rough Milling



these pieces of drop-forged steel is at a table feed of 6 inches per minute on the

NO. 2 PLAIN CINCINNATI GEARED-FEED MILLER.

The cutter makes 120 r.p.m., feeding .050 inch per turn, taking a cut 5-8 inch wide and removes 1-16 inch of stock; then the feed is reduced to .033 inch—4 inches table travel per minute for the finishing cut.

This change in feed is accomplished by the simple movement of the lever without stopping the machine. This is our quick feed-change feature, which is just as important as the geared feed.

How long does it take to change the feed on the millers you are using? If they are not new "Cincinnatis", you are losing a lot of time.

ASK FOR "EXAMPLES OF RAPID MILLING."

We are Milling Specialists.

The Cincinnati Milling Machine Co.

Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Schuchardt & Schutte, Berlin, Cologne, Vienna, St. Petersburg, Brussels and Stockholm. Adolphe Janssens, Paris. Chas. Churchill & Co., London. Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Niles-Bement-Pond Co., 39 Victoria St., London, S. W.

MISCELLANEOUS (Continued from page 446).

FOR SALE—1 Reihle Brake Testing Machine for Gas Engine Work; cost $300.00 new. THE PATTERSON TOOL & SUPPLY CO., Dayton, Ohio.

FOR SALE CHEAP.—An office telephone system with five stations, in good order. Address, "TELEPHONE," care of MACHINERY, 66 West Broadway, New York.

FOR SALE CHEAP.—New treatise on welding and forging all the new steels, and five welding compounds for same. Thermit welding is also explained, and 75 new steel working methods and receipts covering all difficult smithing. Two colored scientific tool tempering charts A and B, also all the above for one dollar. Samples free. W. M. TOY, Sidney, Ohio.

MACHINERY SALESMAN WANTED, to handle as a side line, machines suitable for use in all wood and metal working factories. Address "SALES," care MACHINERY, 66 West Broadway, New York.

MACHINISTS' 50 PAGE BOOK.—Rules and Pointers just from press. Price 25 cents. Address WM. POWLES, 485 North St., St. Paul, Minn.

MACHINISTS send 5 cents in stamps for blue print table of U. S. standard steam, gas and water pipe, giving tapping sizes. Address E. E. MEYER, Allegheny, Pa.

MACHINISTS.—The Monotype Company has openings for intelligent young machinists. For a limited period free instruction will be given to a few, and expenses paid while learning, to fill waiting positions at good wages. Write for application blank to THE LANSTON MONOTYPE MCH. COMPANY, 1231 Callowhill St., Philadelphia, Pa.

PATENT YOUR ORIGINAL IDEAS.—They may be valuable some day. If in doubt as to patentability, write me, giving sketch and full description, and I will give you my opinion as to patentability free of charge. F. H. KING, Patent Lawyer and Solicitor, 1462 Monadnock Bldg., Chicago, Ill.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

SEE my Test Indicator, page 31. H. A. LOWE, Waltham, Mass.

THE Wellman Sole Cutting Machine Co., of Medford, Mass., designs and builds light machinery. Correspondence solicited.

WANTED.—Heavy boring mill and lathe work; also machinery to build on order. KROM MACHINE WORKS, 10 Essex St., Jersey City, N. J.

WANTED.—All kinds experienced engineers, draftsmen, foremen and superintendents to register; positions open. CLEVELAND ENGINEERING AGENCY, Box 71, Station B, Cleveland, O.

WANTED.—Second-hand electric traveling crane, about 30 ft. span, stone capacity. Address POORMAN MFG. CO., Piqua, O.

WANTED—By a practical machinist and marine engineer, position as foreman, master mechanic or superintendent of construction. Contracted and built Rolling Mills, Distillery, Cooperage and Glucose Machinery; also built, tested and set up Marine Engines in steamers. Best of reference. Chicago reference, Robert Tirant, Engine & Tool Builder. Address "J. C. F.," care MACHINERY, 66 West Broadway, New York.

WANTED.—A responsible firm to manufacture on royalty a specialty in machine tools which has been on the market and in successful operation for several years. The present owner lacks the facilities and capital to produce them in sufficiently large quantities. Address "MACHINE TOOL," care of MACHINERY, 66 West Broadway, New York.

WE HAVE COMPLETED a modern, up-to-date foundry and machine shop, equipped the same with the latest and most improved machinery that could be purchased, and are wanting journeymen patternmakers, moulders, and machinists, and invite applications for these positions. Apply or address KENNEY & CO., Scottdale, Pa.

WANTED.—A first-class machine tool salesman to travel in the South for a Southern House. State experience, age, present employment and salary expected. SOUTH, care of MACHINERY, 66 West Broadway, New York.

WANTED.—A first-class foreman to take general charge of a small shop manufacturing power transmitting machinery. Must be a hustler and understand this line of business. State experience, shops employed in, and salary expected. TRANSMISSION, care of MACHINERY, 66 West Broadway, New York.

WANTED.—A machinist in every shop to sell my Calipers and Levels. Liberal proposition. Address E. G. Smith, Columbia, Pa.

WANTED.—First-class floor hands experienced in the erection of Machine Tools, those familiar with lathes or shapers preferred. Steady employment at fair wages. State where now employed and give record of employment for past five years. A good place, fair treatment and congenial surroundings. Town of 30,000, living expenses reasonable. Address, giving full particulars as to age, etc., W., care of MACHINERY, 66 West Broadway, New York.

WANTED.—An American born and educated mechanical engineer to travel, introducing our line of Pneumatic Machinery and Labor Saving Devices for shops, foundries, and other classes of manufacturing plants. Must have some manufacturing experience and ingenuity to apply our devices successfully. CURTIS & CO. MFG. CO., St. Louis, Mo.

WANTED—A few more orders for Gray Iron Castings. Have increased our foundry capacity and would like an opportunity to figure on your work. ATHOL MCHE. CO., Athol, Mass.

WE are constantly increasing the scope of our work, and invite applications for positions from first-class patternmakers, molders and machinists. We always have vacancies. Address THE WESTINGHOUSE MACHINE CO., East Pittsburg, Pa.

WE do pattern work, turret lathe work, machine jobbing, build special machinery, with a modern equipment; also make fine machinery casting. McFARLAND FOUNDRY & MACHINE WORKS, Trenton, N. J.

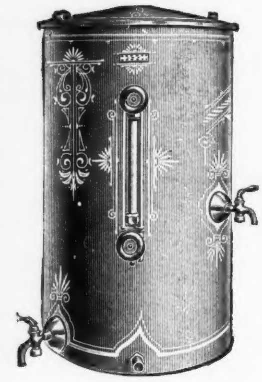
GALVESTON, TEX., September 13, 1902.

Burt Mfg. Co., Akron, Ohio.

Gentlemen:—Answering your favor of September 9th, we beg to state that the oil filter that we have purchased from you and installed on the 28th of May is giving us entire satisfaction and enables us to use the oil over and over again whereas formerly without it, we could not use the oil after it had once been used and discharged into the drip pans, etc.

It is difficult to state just how much we are saving at this time but it seems logical and safe to state that we would be using twice as much oil if we were without the services of your filter.

Yours truly,
TEXAS STAR FLOUR MILLS,
J. Reymershoffer, Pres.



50%

90%

—?

Figure it out.

If one firm is saving fifty per cent. of their oil through the use of Warden Filters, and another concern estimates their saving at ninety per cent., how much will a Warden Filter save in your plant? To facilitate the solving of this problem we will send you a Warden Filter, any size desired, on 30 days' trial—filter to be returned at our expense if the answer isn't 50 per cent. or better.

Catalogue shows all sizes.

The Burt Manufacturing Co.

Main & Howard Sts., Akron, Ohio, U. S. A.

Shelby & Co., London, E. C., England, Sole Agents for Great Britain.

ELYRIA, OHIO, December 11, 1902.

The Burt Mfg. Co., Akron, Ohio.

Gentlemen:—Replying to your favor of the 4th inst. we conferred with our Engineer at the mine, who informed us that he was greatly pleased with your Oil Filter, and that the saving in oil would exceed 50 per cent.; in fact he thought the saving at least 90 per cent.

We take pleasure in recommending your Filter.

Yours truly,
THE FLUSHING COAL COMPANY,
Per T. S. Faxon, Pres.

Supplement to MACHINERY, May, 1903.
Data Sheet No. 20.
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A year's subscription to MACHINERY will be given to anyone sending in tables, data or other information that shall be accepted for one of these data sheets.

PUNCH

CREASE HERE.

ELEMENTS OF STANDARD PIPE SECTIONS.

Nominal Size.	Tap Drill.	Outside Diameter.	Internal Diameter.	Internal Area, Sq. In.	Area of Metal, Sq. In.	Moment of Inertia.	Section Modulus.	Radius of Gyration.	Square of Radius of Gyration.	Weight per foot in Pounds.	Threads per Inch.
N	T	D	d	a	A	I	$\frac{I}{\frac{1}{2}D}$	R	R^2	W	t
1/8	11/32	.405	.27	.0573	.072	.001	.005	.122	.015	.241	27
1/4	7/16	.54	.364	.1041	.125	.003	.012	.163	.027	.420	18
3/8	9/16	.675	.494	.1917	.166	.007	.022	.209	.044	.559	18
1/2	11/16	.84	.623	.3048	.249	.017	.041	.262	.068	.837	14
3/4	15/16	1.05	.824	.5333	.333	.037	.071	.334	.111	1.12	14
1	1 3/16	1.315	1.048	.8626	.495	.107	.162	.343	.118	1.68	11½
1¼	1 1/2	1.66	1.38	1.496	.668	.195	.235	.540	.291	2.24	11½
1½	1 3/4	1.9	1.611	2.038	.797	.309	.325	.681	.463	3.68	11½
2	2 1/4	2.375	2.067	3.356	1.07	.666	.561	.787	.620	4.61	11½
2½	2 11/16	2.875	2.468	4.784	1.71	1.53	1.07	.947	.898	5.74	8
3	3 5/16	3.5	3.067	7.388	2.24	3.02	1.73	1.16	1.35	7.54	8
3½	3 13/16	4.0	3.548	9.887	2.68	4.79	2.39	1.34	1.79	9.00	8
4	4 5/16	4.5	4.026	12.73	3.17	7.23	3.21	1.51	2.28	10.7	8
4½		5.0	4.508	15.96	3.67	10.41	4.16	1.68	2.83	12.3	8
5		5.563	5.045	19.99	4.32	15.2	5.47	1.88	3.52	14.5	8
6		6.625	6.065	28.89	5.58	28.2	8.50	2.25	5.04	18.8	8
7		7.625	7.023	38.74	6.93	46.5	12.2	2.59	6.72	23.3	8
8		8.625	7.982	50.04	8.39	72.4	16.8	2.94	8.63	28.2	8
9		9.625	8.937	62.73	10.03	108.	22.9	3.28	10.8	33.7	8
10		10.75	10.019	78.84	11.92	161.	29.9	3.67	13.5	40.1	8
11		12.00	11.25	99.40	13.70	232.	38.6	4.12	16.9	46.0	8
12		12.75	12.00	113.1	14.58	279.	42.8	4.38	19.2	49.0	8
14 O.D.		14.00	13.25	137.9	16.05	373.	53.3	4.82	23.2	53.9	8
15 O.D.		15.00	14.25	159.5	17.23	461.	61.5	5.15	26.5	57.9	8
16 O.D.		16.00	15.25	182.6	18.41	562.	70.3	5.53	30.5	61.8	8

Computed by John S. Myers, New York City.

CREASE HERE.

ELEMENTS OF EXTRA STRONG PIPE SECTIONS.

N	D	d	a	A	I	$\frac{I}{\frac{1}{2}D}$	R	R^2	W
1/8	.405	.205	.033	.086	.001	.006	.114	.013	.29
1/4	.54	.294	.068	.161	.004	.014	.154	.024	.54
3/8	.675	.425	.139	.219	.009	.025	.200	.040	.74
1/2	.84	.542	.231	.323	.020	.048	.250	.062	1.09
3/4	1.05	.736	.452	.414	.045	.086	.321	.103	1.39
1	1.315	.951	.710	.648	.107	.162	.406	.165	2.17
1¼	1.66	1.272	1.27	.893	.244	.270	.523	.273	3.00
1½	1.9	1.494	1.75	1.08	.395	.416	.605	.365	3.63
2	2.375	1.933	2.94	1.50	.877	.738	.766	.586	5.02
2½	2.875	2.315	4.21	2.28	1.94	1.35	.923	.852	7.67
3	3.5	2.892	6.57	3.05	3.93	2.28	1.14	1.29	10.3
3½	4.0	3.358	8.86	3.71	6.33	3.16	1.31	1.70	12.5
4	4.5	3.818	11.45	4.45	9.72	4.32	1.48	2.18	15.0
5	5.563	4.813	18.19	6.12	20.7	7.43	1.84	3.38	20.5
6	6.625	5.750	25.97	8.51	40.9	12.4	2.19	4.81	28.6

ELEMENTS OF DOUBLE EXTRA STRONG PIPE SECTIONS.

N	D	d	a	A	I	$\frac{I}{\frac{1}{2}D}$	R	R^2	W
1/2	.84	.244	.047	.507	.024	.058	.213	.048	1.70
3/4	1.05	.422	.139	.727	.058	.111	.283	.080	2.44
1	1.315	.587	.271	1.09	.141	.214	.360	.130	3.65
1¼	1.66	.885	.615	1.55	.343	.413	.471	.221	5.20
1½	1.9	1.088	.93	1.91	.571	.601	.547	.300	6.40
2	2.375	1.491	1.74	2.69	1.32	1.11	.701	.491	9.02
2½	2.875	1.755	2.42	4.07	2.89	2.01	.842	.709	13.7
3	3.5	2.284	4.10	5.52	6.03	3.45	1.05	1.09	18.6
3½	4.0	2.716	5.79	6.77	9.90	4.95	1.21	1.46	22.7
4	4.5	3.136	7.72	8.18	15.4	6.84	1.37	1.88	27.5
5	5.563	4.063	12.97	11.34	33.6	12.1	1.72	2.96	38.1
6	6.625	4.875	18.67	15.90	66.9	20.2	2.06	4.23	53.1

Computed by John S. Myers, New York City.

6	6.625	4.875	18.67	15.90	66.9	20.2	2.06	4.23	53.1	
15 O.D.	15.00	14.25	159.5	17.23	461.	61.5	5.15	26.5	57.9	8
16 O.D.	16.00	15.25	182.6	18.41	562.	70.3	5.53	30.5	61 8	8

S 6 x 9 DATA SHEETS.

These data sheets are intended to be cut into four sections, 6 x 9 inches in size, as indicated by the straight lines. They may then be bound into note book form for convenient reference by means of staples inserted in holes punched at the points indicated.

PUNCH O PUNCH O

CREASE HERE.

NUMBER OF REVOLUTIONS REQUIRED TO OBTAIN SURFACE SPEEDS OF FROM 20 FEET TO 60 FEET PER MINUTE ON DIAMETERS FROM 1 INCH TO 40 INCHES.

Diam., Inches.	Circum., inches.	Circum., feet.	Surface Speeds per Minute. 20 feet.	25 feet.	30 feet.	35 feet.	40 feet.	45 feet.	50 feet.	60 feet.
1	3.1416	0.261	76.397	95.493	114.590	133.690	152.789	171.887	190.986	229.182
2	6.2832	0.523	38.197	47.746	57.296	66.845	76.394	85.944	95.493	114.590
3	9.4248	0.785	25.465	31.831	38.197	44.563	50.929	57.296	63.662	76.394
4	12.5664	1.047	19.099	23.873	28.647	33.422	38.197	42.971	47.746	57.296
5	15.7080	1.309	15.279	19.098	22.918	26.738	30.557	34.377	38.197	45.836
6	18.850	1.570	12.732	15.915	19.098	22.281	25.465	28.648	31.831	38.197
7	21.991	1.832	11.167	13.641	16.370	19.098	21.826	24.555	27.283	32.740
8	25.133	2.094	9.55	11.936	14.324	16.711	19.098	21.486	23.873	28.647
9	28.274	2.356	8.49	10.610	12.732	14.854	16.976	19.098	21.220	25.464
10	31.416	2.618	7.64	9.55	11.459	13.369	15.278	17.188	19.098	22.918
11	34.558	2.879	6.94	8.68	10.417	12.100	13.889	15.626	17.362	20.834
12	37.699	3.141	6.37	7.96	9.55	11.083	12.732	14.324	15.915	19.098
13	40.841	3.403	5.88	7.35	8.81	10.283	11.753	13.222	14.691	17.629
14	43.982	3.665	5.47	6.82	8.19	9.55	11.167	12.277	13.641	16.370
15	47.124	3.927	5.09	6.37	7.64	8.91	10.185	11.459	12.732	15.278
16	50.265	4.188	4.77	5.97	7.16	8.36	9.55	10.743	11.936	14.324
17	53.407	4.450	4.49	5.62	6.74	7.86	8.99	10.018	11.234	13.481
18	56.549	4.712	4.24	5.31	6.36	7.43	8.49	9.55	10.610	12.732
19	59.690	4.974	4.02	4.91	6.03	7.04	8.04	9.05	10.028	12.062
20	62.832	5.236	3.82	4.77	5.73	6.68	7.64	8.59	9.55	11.459
21	65.973	5.497	3.64	4.55	5.46	6.37	7.28	8.19	9.09	10.913
22	69.115	5.759	3.47	4.34	5.21	6.08	6.94	7.81	8.68	10.417
23	72.257	6.021	3.32	4.15	4.98	5.81	6.64	7.47	8.30	9.987
24	75.398	6.283	3.18	3.98	4.77	5.57	6.37	7.16	7.96	9.549
25	78.540	6.545	3.06	3.82	4.58	5.35	6.11	6.88	7.64	9.167
26	81.681	6.806	2.94	3.67	4.41	5.14	5.88	6.61	7.35	8.81
27	84.823	7.068	2.83	3.53	4.34	4.95	5.66	6.37	7.07	8.49
28	87.965	7.330	2.73	3.41	4.09	4.77	5.47	6.14	6.82	8.19
29	91.106	7.592	2.63	3.29	3.94	4.61	5.27	5.93	6.59	7.90
30	94.248	7.854	2.55	3.18	3.82	4.46	5.09	5.73	6.37	7.64
31	97.389	8.115	2.46	3.08	3.69	4.31	4.93	5.54	6.16	7.39
32	100.53	8.377	2.39	2.98	3.58	4.18	4.77	5.37	5.97	7.16
33	103.67	8.639	2.32	2.89	3.47	4.05	4.63	5.21	5.79	6.95
34	106.81	8.901	2.25	2.81	3.37	3.93	4.49	5.06	5.62	6.74
35	109.96	9.163	2.18	2.73	3.27	3.82	4.37	4.91	5.46	6.55
36	113.10	9.425	2.12	2.65	3.18	3.71	4.24	4.77	5.31	6.37
37	116.24	9.686	2.06	2.58	3.09	3.61	4.13	4.64	5.16	6.19
38	119.38	9.948	2.01	2.51	3.02	3.52	4.02	4.52	5.03	6.03
39	122.52	10.210	1.96	2.45	2.94	3.43	3.92	4.41	4.90	5.88
40	125.66	10.472	1.91	2.39	2.86	3.34	3.82	4.29	4.77	5.73

Computed by E. M. Willson, Madison, Wis.

PUNCH O PUNCH O

CREASE HERE.

TIME REQUIRED FOR CUTTING TOOL TO TRAVEL 1 INCH, WHEN THE FEED IS 1-32 INCH PER REVOLUTION.

Diam.	Surface Speeds per Minute. 20 feet.		25 feet.		30 feet.		35 feet.		40 feet.		45 feet.		50 feet.		60 feet.	
Inches.	Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.
1	0	25	0	20	0	17	0	14	0	12	0	11	0	10	0	8
2	0	50	0	40	0	33	0	29	0	25	0	22	0	20	0	17
3	1	15	1	0	0	50	0	43	0	38	0	33	0	30	0	25
4	1	40	1	20	1	7	0	57	0	50	0	45	0	40	0	33
5	2	6	1	41	1	24	1	12	1	3	0	56	0	50	0	42
6	2	31	2	1	1	41	1	26	1	15	1	7	1	0	0	50
7	2	56	2	21	1	57	1	41	1	28	1	18	1	10	0	58
8	3	21	2	41	2	14	1	35	1	40	1	29	1	20	1	7
9	3	46	3	1	2	31	2	9	1	53	1	41	1	30	1	15
10	4	11	3	21	2	48	2	24	2	6	1	52	1	41	1	24
11	4	36	3	41	3	4	2	38	2	18	2	3	1	51	1	32
12	5	2	4	1	3	21	2	52	2	31	2	14	2	1	1	41
13	5	27	4	21	3	38	3	7	2	43	2	25	2	11	1	49
14	5	52	4	41	3	55	3	21	2	56	2	36	2	21	1	57
15	6	17	5	2	4	11	3	35	3	8	2	48	2	31	2	6
16	6	42	5	22	4	28	3	50	3	21	2	59	2	41	2	14
17	7	7	5	42	4	45	4	4	3	34	3	10	3	51	2	22
18	7	32	6	2	5	2	4	18	3	46	3	21	3	1	2	31
19	7	57	6	22	5	18	4	33	3	59	3	32	3	11	2	39
20	8	22	6	42	5	35	4	47	4	11	3	43	3	21	2	48
21	8	48	7	2	5	52	5	2	4	24	3	55	3	31	2	56
22	9	13	7	22	6	9	5	16	4	36	4	6	3	41	3	4
23	9	38	7	42	6	25	5	30	4	49	4	17	3	51	3	12
24	10	3	8	3	6	42	5	45	5	2	4	28	4	1	3	21
25	10	28	8	23	6	59	5	59	5	15	4	39	4	11	3	30
26	10	53	8	43	7	16	6	13	5	27	4	50	4	21	3	38
27	11	19	9	3	7	32	6	28	5	39	5	2	4	31	3	46
28	11	44	9	23	7	49	6	42	5	52	5	13	4	41	3	55
29	12	9	9	43	8	6	6	56	6	4	5	24	4	51	4	3
30	12	34	10	3	8	23	7	11	6	17	5	35	5	2	4	11
31	12	59	10	23	8	39	7	25	6	30	5	46	5	12	4	19
32	13	24	10	43	8	56	7	40	6	42	5	57	5	22	4	28
33	13	49	11	3	9	13	7	54	6	55	6	9	5	32	4	36
34	14	15	11	24	9	30	8	8	7	7	6	20	5	42	4	45
35	14	40	11	44	9	46	8	23	7	20	6	31	5	52	4	53
36	15	5	12	4	10	3	8	37	7	32	6	42	6	2	5	2
37	15	30	12	24	10	20	8	51	7	45	6	53	6	12	5	10
38	15	55	12	44	10	37	9	6	7	57	7	4	6	22	5	18
39	16	20	13	4	10	53	9	20	8	10	7	16	6	32	5	27
40	16	45	13	24	11	11	9	34	8	22	7	27	6	42	5	35

Computed by E. M. Willson, Madison, Wis.